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AQUATIC AND WILDLIFE RESOURCES

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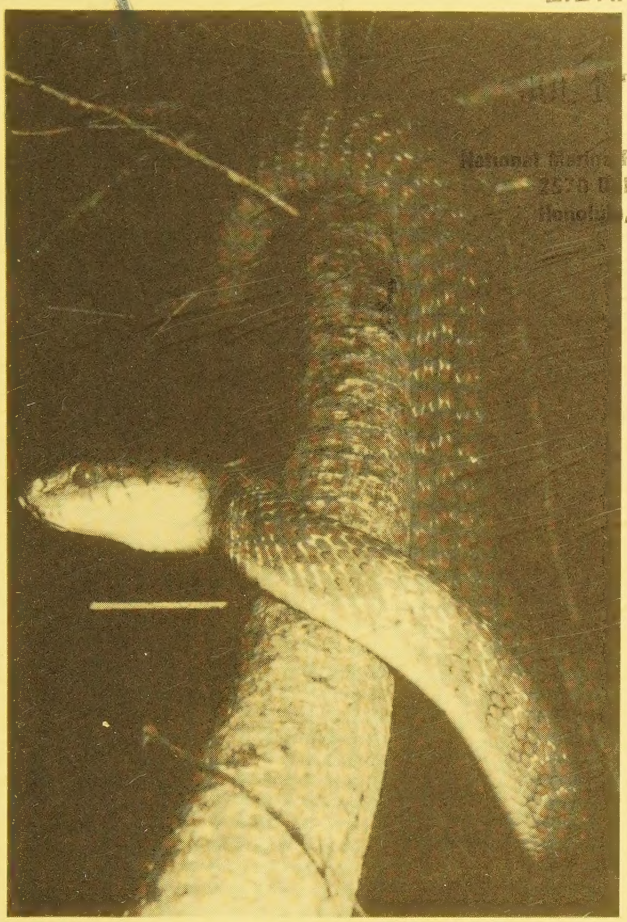

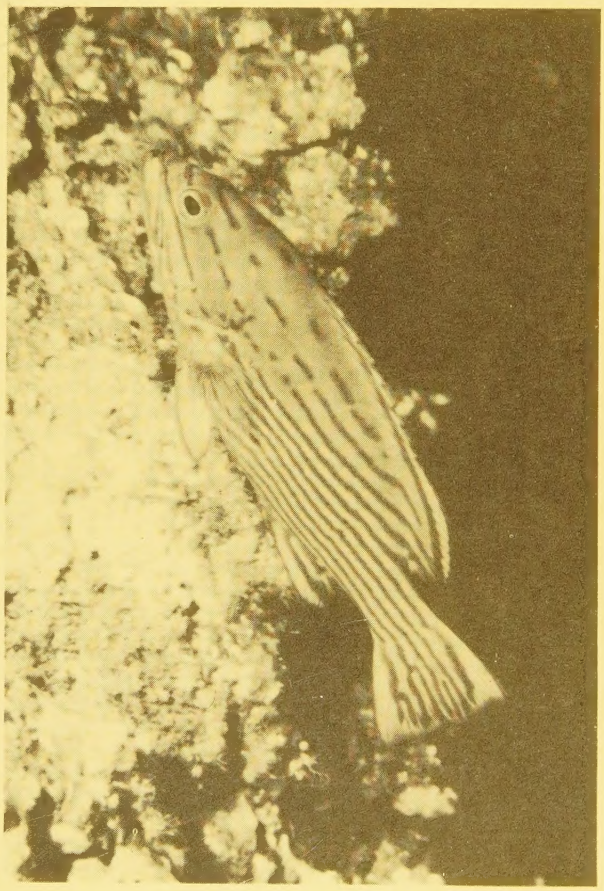

DEPARTMENT OF AGRICULTURE

OCTOBER 1, 1982 - SEPTEMBER 30, 1983
FY 1983

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'83

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ANNUAL REPORT
FISCAL YEAR 1983

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
Harry T. Kami, Chief

DEPARTMENT OF AGRICULTURE
Elizabeth P. Torres, Director

Edited BY:
Robert D. Anderson
Michael E. Molina

PERIOD COVERED:
October 1, 1982 to September 30, 1983

ACKNOWLEDGEMENTS

The Aquatic & Wildlife Resources Division, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

The members of the Guam Fishing & Boating Association, the Seventh Marianas Fishing Derby Committee and the Manager of the Guam Fishermen's Coop for allowing fishery biologists to examine their fish.

All fishermen and fish weir operators who have cooperated with fishery data collection.

All farmers engaged in aquaculture who cooperated by providing information and harvest data.

All hunters who have cooperated with wildlife data collection by submitting hunter report cards.

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The Commander of the Marianas Section, U.S. Coast Guard.

The staff and management of KGTF for assistance in producing conservation related public service announcements.

The members of both print and electronic media for their assistance with our conservation education program.

The Cushing Zoo for cooperating with the Division by caring for injured wildlife.

The personnel of the Naval Oceanographic Command Detachment, U.S. Naval Air Station, Guam, for providing weather data.

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GUAM FISH AND WILDLIFE INVESTIGATIONS
PROJECT FW-2R-20
Federal Aid in Fish and Wildlife Restoration Acts

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs.

PERIOD COVERED: October 1, 1982 to September 30, 1983

JOB OBJECTIVES: To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.

2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Offices.

3. Administer all personnel matters including recruitment of off-island staff.

4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division Chief and his staff were involved in preparing required documentation for the DJ-PR funded Guam Fish and Wildlife Investigation Program (FW-2R) and the Guam Endangered Species Program (E-1) funded under a Section 6 Cooperative Agreement. Documentation included various Project Agreement and AFA amendments, and the Project Agreement for Segment 21.

Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government of Guam Accounting and Budget Offices to ensure fiscal integrity. Efforts were also begun to contract an accounting firm to conduct an audit of our Federal Aid programs.

Numerous personnel changes took place during the fiscal year. Alan Hosmer, Fisheries Section Supervisor, resigned and was ultimately replaced by Mike Molina, who was promoted into that position. Fisheries Biologist Christine Palomo, resigned at the end of the segment to return to school. Celestino Aguon, who has worked as part-time since 1978, became a

full-time Wildlife Biologist early in the segment, and was joined on the staff by Julie Savidge, Bob Beck, and Paul Conry. Nancy Mafnas joined the Federal Aid funded staff as a Clerk-Typist.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources.

Division staff made a number of off-island trips related to Federal Aid programs. Division Chief Harry Kami and Assistant Chief Robert D. Anderson attended a Federal Aid workshop in Honolulu and later attended the Symposium on Resource Investigations in the Northwest Hawaiian Islands. Mr. Kami was also invited to participate in a Research/Management Coordination meeting held by the Fish & Wildlife Service in Volcano, Hawaii.

Biologist Julie Savidge spent two weeks conducting avian disease research on Saipan in the Commonwealth of the Northern Mariana Islands (CNMI). She also attended the Centennial Meeting of the American Ornithologists' Union and visited the National Wildlife Health Laboratory and the Denver Wildlife Research Center on the same trip.

Biologist Robert Beck attended a Symposium on Breeding Birds in Captivity in Los Angeles, California.

Biologist Gary Wiles spent approximately twenty-six days in the Commonwealth of the Northern Mariana Islands conducting fruit bat surveys with the Oxford University Expedition to the Mariana Islands and with CNMI biologists.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT.: FW-2R-20
SUB-PROJECT NO.: C-2
JOB NO.: 1

PROJECT TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

PERIOD COVERED: October 1, 1982 to September 1983

BACKGROUND

The rapid development of Guam's economy has placed increasing demands upon Guam's natural resources. A trend toward urbanization has brought growth in the construction of residential, recreational, commercial, military, industrial, and public utility facilities, all of which have some impact upon the environment. To help minimize long-term adverse impacts of such development, the Division of Aquatic and Wildlife Resources (DAWR) has taken an increasingly active role in the area of technical guidance. Recently, the DAWR's responsibilities in this area have been increasing rapidly because review is now legally required for many development plans, permit applications, and impact statements.

OBJECTIVES

I. To minimize adverse impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.

II. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

FINDINGS

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations have been conducted in many cases as a part of the review process.

Various Division staff members actively serve as members of the following groups:

1. Western Pacific Regional Fisheries Management Council
2. Cocos Lagoon Task Force
3. Region IX Regional Response Team - Oceania
4. Animal Impact Screening Committee
5. Territorial Seashore Park Management Committee
6. Subdivision and Development Review Committee

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Navy, the U.S. Coast Guard, the U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Division staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members participated in National Wildlife Week, Chamorro Week, Earth Week and Environment Fair activities and gave talks to a number of civic groups, sportsmans clubs, and school and university classes.

Some specific Technical Assistance activities included:

1. As members of the Regional Response team, Division staff met numerous times with representatives of the U.S. Coast Guard, Guam Environmental Protection Agency, and the Guam Oil Refining Company to discuss the clean-up of the oil spill in the Santali Marsh and to plan the most effective clean-up strategy. Several field inspections of the oil spill site were conducted as well.

2. As members of the Animal Impact Screening Committee, Division staff met to discuss the possible introduction of Clarias batrachus for aquaculture. Staff also reviewed all applications to import live organisms to Guam.

3. As members of the Cocos Lagoon Task Force, Division staff met several times to develop planning guidelines for the Cocos Island/Cocos Lagoon area in southern Guam. One important aspect of this activity was to provide input to the U.S. Army Corps of Engineers who were conducting a separate study of the development potential of this area.

4. The Division was represented on the Subdivision and Development Review Committee, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and Wildlife resources be considered in land use planning.

5. Division staff attended a workshop sponsored by the U.S. Army Corps of Engineers on their Guam Comprehensive Study.

6. Division staff met monthly with supervisors of Customs and Quarantine to discuss animal imports and endangered species questions.

7. The Division provided data regarding fishing pressure in Agana Bay to the Army Corps of Engineers for use in one of their planning studies.

8. The Division reviewed the Army Corps of Engineers plans for Paseo shoreline protection and attended a public meeting held on this subject.

9. The Division reviewed the Army Corps of Engineers tentative plans for construction of a small boat harbor in the Merizo area and attended public meetings held on this subject.

10. The Division reviewed the Army Corps of Engineers Permit application by Guam Telephone Authority to install an undersea cable to Cocos Island and received another permit application for installation of float-line to delineate swimming area at Hotel beach.

11. The Division reviewed the plans and Army Corps of Engineers permit application by the Department of Public Works to construct a new bridge over the Pago River.

12. A meeting regarding planning considerations for the War in the Pacific National Park was attended.

13. Input was provided to the Aquaculture Association regarding the needs for a prawn and fish hatchery on Guam.

14. Two days were spent discussing federal laws that impact the development of fisheries on Guam with several Government of Guam agencies and the National Marine Fisheries Service task force team.

15. Assistance was provided the National Wetland Inventory mapping team sent to Guam by the U.S. Fish and Wildlife Service in early 1983 to do field inspection and ground-trutting for the mapping project. Further assistance was provided in June, 1983, when a Wetland Mapping Workshop was held and further field inspections conducted.

16. Division staff met with representatives of other Government of Guam agencies to review mitigation plans for the Navy's proposed ammunition wharf at Adotgon Point. The plans of the Navy to establish two ecological reserves in mitigation were reviewed.

17. An estimate of daily fishing boat activity at the Agana Boat Basin was provided to Mobil Oil Company upon request.

18. Two articles, including an analysis of fishing at the 1982 Marianas Fishing Derby and a summary of trolling data compiled at the Agana Boat Basin in FY 82 were provided to the Marianas Fishing Derby Committee for the FY 1983 program.

19. Staff met with representatives of the U.S. Air Force and Marine Corps on several occasions regarding the planning of a Marine training exercise in Northwest Field, with the objective of reducing the impacts on the wildlife resource. The exercise was monitored while in progress as well.

20. Staff met with representatives of the U.S. Navy's Seabees regarding a planned Seabee training exercise in Northwest Field with the objective of reducing the impacts on the wildlife resource. This exercise was also monitored while in progress.

21. Division staff met with the Bird Strike Task Force at Andersen Air Force Base and provide recommendations regarding the reduction of bird-caused flight hazards.

22. Division staff met with the Speaker of the 17th Guam Legislature and with various legislative staff to discuss the establishment of a locally-funded program for the recovery of Guam's native birds and for research into the biology and control of the snake.

23. Division staff met with the Navy Public Works Center to discuss snake-caused power outages and possible control methods.

24. Division staff provided assistance to Drs. Janet and Timothy Williams of Swarthmore College, who were on-island conducting radar studies of bird migration.

25. Division staff provided considerable technical assistance to the U.S. Air Force at Andersen Air Force Base through reviews of plans for training exercises, fill disposal for new oil storage of their Golf Course, and control of deer in flightline areas.

26. Division staff spoke to numerous school and university classes, sportsman clubs, dive clubs and classes, the Audubon Society. Staff also presented training briefing to military security staff at various bases and to a new group of Guam Customs and Quarantine Officers.

27. Numerous animal damage complaints by farmers were investigated and control permits issued it warranted. Recommendations regarding protection of crops against animal damage were made.

28. Considerable assistance was provided the public and local veterinarians regarding avian diseases on Guam as part of our effort to determine if avian disease may be responsible for the decline of Guam's birds.

29. Technical advice regarding care and feeding of animals was provided to the Cushing Zoo.

30. Division staff worked closely with the Attorney General's Office and their Prosecution Division in regard to a number of legal issues, including the definition of wild animals, Guam's fish and game laws, and the hunting and fishing regulations.

31. Division staff provided training in creel censusing techniques to fisheries staff of the Department of Natural Resources, Commonwealth of the Northern Mariana Islands.

32. Division staff presented testimony at a National Marine Fisheries Service Public Hearing reviewing the regulations relative to taking certain sea turtles in Guam's waters.

33. Division staff met with the Rotary Club of Guam regarding their interest in making a contribution to fish and wildlife conservation on Guam.

34. Division staff participated in the Guam Environment Fair by setting up a display and answering numerous questions from the public regarding fish and wildlife resources.

35. Division staff met with Mr. George Chan of the Dept. of Energy, Commonwealth of the Northern Mariana Islands regarding the potential of aquaculture.

36. Division staff provided written and oral comments regarding the proposed construction of the Nauru Hotel at Tumon Bay, Guam.

37. Division staff met with Mr. Jesus Patricio regarding his proposal to begin an oyster mariculture project in Apra Harbor.

38. Division staff provided planning assistance in the Governor's Aquaculture Symposium.

39. Division staff provided planning assistance in World Food Day activities.

40. Division staff provided comments to the 17th Guam Legislature regarding a proposed Bill 330, "An Act to Add a New Chapter VII to Title XLIV of the Government Code to Create the Guam Bureau of Fisheries Industry".

41. Division staff attended a workshop on the National Environmental Protection Act and its relevance in reviewing Environmental Impact Assessments and Statements.

Report prepared by: Robert D. Anderson and Michael E. Molina

GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-20
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 1

JOB TITLE: Offshore Creel Census

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

With a few exceptions, offshore fish landings were monitored on four days each month at the Agana Boat Basin. On these days participation surveys were conducted during noncensus periods at the Boat Basin in order to assess the ratio of interviewed to noninterviewed boats per 24 hr. period. Surveys were also made in order to assess the ratio of boats utilizing the Agana Boat Basin to boats utilizing other landings per 24 hr. period. The results of these surveys indicate that previous estimates of participation during noncensused hours and participation at other landings were much too conservative. The estimated annual catch of FY 82 was recalculated utilizing FY 83 participation ratios. Reanalysis of catch estimates for years prior to FY 83 utilizing more realistic participation estimates will be incorporated into a multi-year report at a later date.

The total estimated island-wide finfish catch for all methods combined was 275.4 metric tons (m.t.). Trolling accounted for 249.4 m.t., followed by bottomfishing (20.1 m.t.), spearfishing (2.7 m.t.), and all other methods combined (3.3 m.t.). An estimated 47,104 boat-hours were spent fishing during 7,469 boat trips. CPUE (Kg/boat hour fished) for trolling was 6.67, for bottomfishing, 2.64, and for spearfishing, 2.47. A reanalysis of FY 82 data utilizing FY 83 participation figures yielded a total catch of 275.3 m.t., nearly identical to that of FY 83.

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods and annual harvests. To this end, the Division of Aquatic & Wildlife Resources (DAWR) has been conducting interviews of offshore fishermen for more than six years.

OBJECTIVES

1. To quantify fishing participation, effort and catch, which occurs outside the reef margin in boats.

2. To collect biological data from specimens examined during interviews.

PROCEDURES

Similar to last year, the FY 83 offshore creel census program was designed to maximize the collection of data obtained per unit time spent in the field. Thus, censuses were generally done between the hours of 1700 and 2100 to correspond with the bulk of daily returning fishing parties.

As designed, two weekend/holiday and two weekday censuses were to be made each month at the Agana Boat Basin. However, during the month of April only one weekday census was conducted, and during the months of February and May only one weekend census was conducted. Unlike last year, no census days were cancelled or rescheduled due to inclement weather. Since the census days were chosen randomly, weather was not taken into consideration in the analysis. FY 83 was essentially storm-free and no more than two days during the entire year were considered unfishable.

Estimates of the number of fishing parties returning outside the census period were made in order to calculate their contribution to the total participation, effort and catch of each census day. This was done in a variety of ways which included interviewing fishermen, personnel of the Fishermen's Cooperative, and residents living on boats berthed at the Agana Boat Basin; and by counting empty berths and parked trailers hitched to vehicles during noncensused hours. In addition, counts of empty trailers and berths at Merizo Pier, Apra Harbor and other launch areas were taken during inshore participation censuses (see Study No. F-1, Job 2) in order to more closely estimate the number of boats not utilizing the Agana Boat Basin. The island-wide expansion of data is based on catch rates obtained solely at the Agana Boat Basin.

ANALYSIS

All data collected during FY 83 were entered into computerized files and expanded utilizing a program based on the algorithms outlined in the National Marine Fisheries Service Administrative Report H-83-21C (see Job 3). Since it was possible to obtain only an instantaneous estimate of offshore participation at launch points other than the Agana Boat Basin, a 24-hour island-wide participation estimate was made utilizing the hypothetical relationship:

$$I_p = \frac{A_t}{\overline{A}_i} \times I_i + A_p$$

where: I_p = estimated island-wide 24-hr. participation for a given day,

I_i = instantaneous island-wide counts for that day,

A_t = estimated 24 hr. participation at Agana Boat Basin,

A_i = instantaneous participation counts at the Agana Boat Basin, and

A_p = estimated 24 hr. participation for a given day at the Agana Boat Basin.

This was done separately on data obtained during WD and WE/H type census days.

An expansion was done for each month and for the FY 83 year as a whole. The output of each monthly expansion includes standard errors and 90% confidence limits for catch, effort and participation based on 4 sample days. The sums of total catch, effort and participation estimates for all months were used as annual estimates, although calculations of standard errors and 90% confidence limits for the year were not possible by this method. In contrast, annual standard error and 90% confidence limits were estimated by running an expansion for the year as a whole with a sample size of 45 days. However, this method does not consider differences in month lengths; and since different calculations result in different rounding errors, a slightly different annual estimate is produced which is not considered as accurate as that derived by summing monthly estimates.

RESULTS

Trolling

CPUE and estimated monthly and annual catch and effort are presented in Table 1.

An estimated 249.4 m.t. of troll-caught fish were landed island-wide during FY 83. Monthly catches ranged from a high of 45.4 m.t. in March to a low of 3.1 mt. in June (Figure 1). An estimated 37,405 boat-hours were spent fishing with a mean CPUE of 6.67 kg/boat-hr. Monthly CPUE ranged from 10.99 kg/boat-hr. in April to 2.09 kg/boat hr. in June.

Typically, five major species accounted for the bulk of the catch (95.0%; Table 2). These were mahimahi (Coryphaena hippurus, 29.3%), skipjack tuna (Katsuwonus pelamis, 23.9%), wahoo (Acanthocybium solandri, 19.8%), and blue marlin (Makaira nigricans, 3.0%). Scombrids collectively accounted for 63.7% of the catch. In general, catches and seasonality were similar to that of previous years (Figure 2). However, there were a few notable exceptions. Mahimahi appeared relatively early producing a small peak catch of nearly 4 m.t. in November. Wahoo, usually most abundant in November, were more abundant in March when 13.5 mt.t. were caught. The sailfish (Istiophorous platypterus), usually rarely caught, appeared in low numbers throughout the year and accounted for 27% (2.8 m.t.) of the billfish catch (10.2 m.t.) which, as a whole, was relatively low. The reason for these exceptions may lie in the anomalous oceanographic conditions associated with El-Nino, which prevailed in the Western Pacific throughout virtually all of FY 83.

Table 1. Offshore creel survey expansion for trolling, monthly summary data, FY 83. Catch is in Kg, effort in boat hours fished, and CPUE in Kg/boat hour fished.

MONTH	MONTHLY CATCH	STD ERR	DF	90% CONF. LMT	MONTHLY EFFORT	STD ERR	DF	90% CONF. LMT	CPUE
OCT	25,207.3	5,761.2	3	13,556.1	4,280.0	729.1	3	1,715.7	5.89
NOV	25,517.6	4,892.6	3	11,512.4	3,464.0	653.6	3	1,538.0	7.37
DEC	17,412.4	5,215.1	3	12,271.2	2,813.0	347.9	3	818.6	6.19
JAN	9,780.6	3,949.0	3	9,292.1	1,351.7	122.6	3	288.6	7.24
FEB	12,867.3	-	2	-	2,953.4	-	2	-	4.36
MAR	45,425.1	2,647.5	3	6,229.6	5,378.7	787.5	3	1,853.0	8.45
APR	38,208.8	-	2	-	3,477.5	-	2	-	10.99
MAY	16,273.1	-	2	-	2,250.8	-	2	-	7.23
JUN	3,115.1	1,220.3	3	2,871.3	1,492.9	401.8	3	945.5	2.09
JUL	17,525.1	2,653.3	3	6,243.1	3,771.7	421.2	3	991.2	4.65
AUG	21,419.3	4,334.1	3	10,198.1	2,968.6	381.9	3	898.5	7.22
SEP	16,628.7	7,083.5	3	16,667.5	3,202.8	1,065.9	3	2,508.1	5.19
FY'83:	249,380.2	-	-	-	37,405.1	-	-	-	6.67

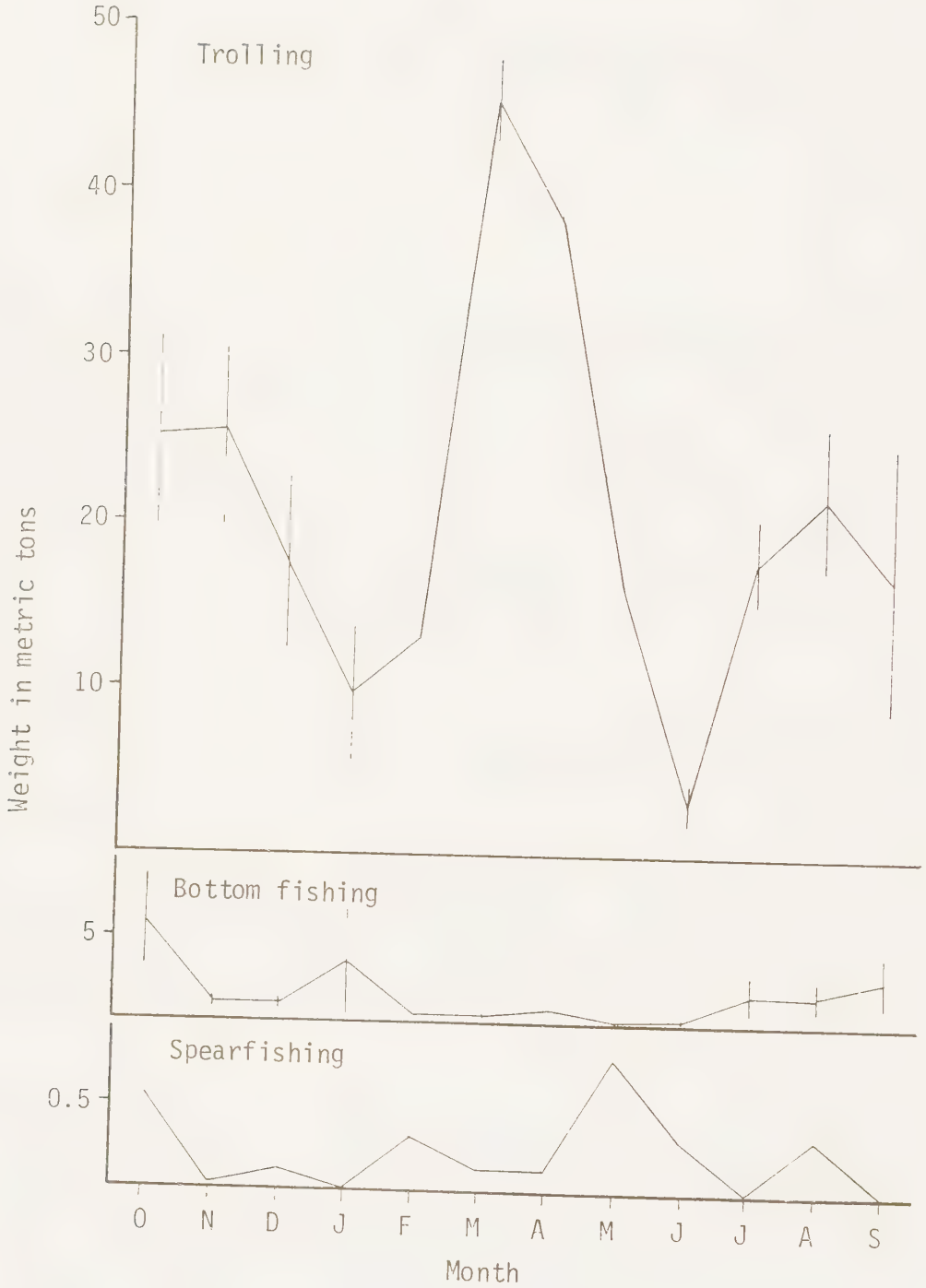


Figure 1. Monthly fluctuations in the estimated catches of three major offshore fisheries during FY 83 with standard error indicated when available. Note that the scale for spearfishing is ten times the scale for trolling and bottom fishing.

Table 2. Monthly and annual composition of the FY'83 trolling catch by family and species. Weights are in metric tons, rounded to the nearest tenth.

Family or Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY 83 m.t.	% of Total
Carcharhinidae											1.5		1.5	0.6
Elagatis bipinnulatus	1.2	<0.1	<0.1	<0.1	<0.1					0.1			1.6	0.6
Caranx spp.							0.1	0.2				0.1	0.4	0.2
Coryphaena hippurus	0.2	4.0	1.5	4.4	8.6	24.2	20.0	8.7	4.0	0.6	0.4		73.1	29.3
Sphyraena barracuda	0.3	0.2	<0.1	0.1		0.4	0.7	0.3		0.4	0.4	0.2	3.2	1.3
Sphyraena spp.	0.1	0.1				0.3							0.5	0.2
Gempylidae						<0.1	<0.1						0.1	<0.1
Acanthocybium solandri	4.1	8.4	3.7	2.0	1.8	13.5	5.4	0.8	0.1	1.1	4.4	4.1	49.4	19.8
Euthynnus affinis	<0.1		<0.1			0.1	<0.1	0.1			0.1		0.3	0.1
Gymnosarda unicolor	1.5		0.1	0.3		<0.1	0.3						2.2	0.9
Katsuwonus pelamis	3.9	6.0	5.0	0.5	2.3	5.5	8.6	5.2	1.5	9.4	4.6	7.0	59.6	23.9
Thunnus albacares	12.7	6.7	6.5	2.5	0.1	0.9	2.0	1.0	0.5	3.5	7.3	3.7	47.4	19.0
Makaira nigricans	1.1								0.6	2.4	1.8	1.5	7.4	3.0
Istiophorus platypterus			0.5			0.4	1.0				0.8		2.8	1.1
Total catch by month	25.2	25.5	17.4	9.8	12.9	45.4	38.2	16.3	3.1	17.5	21.4	16.6	249.4	100.0

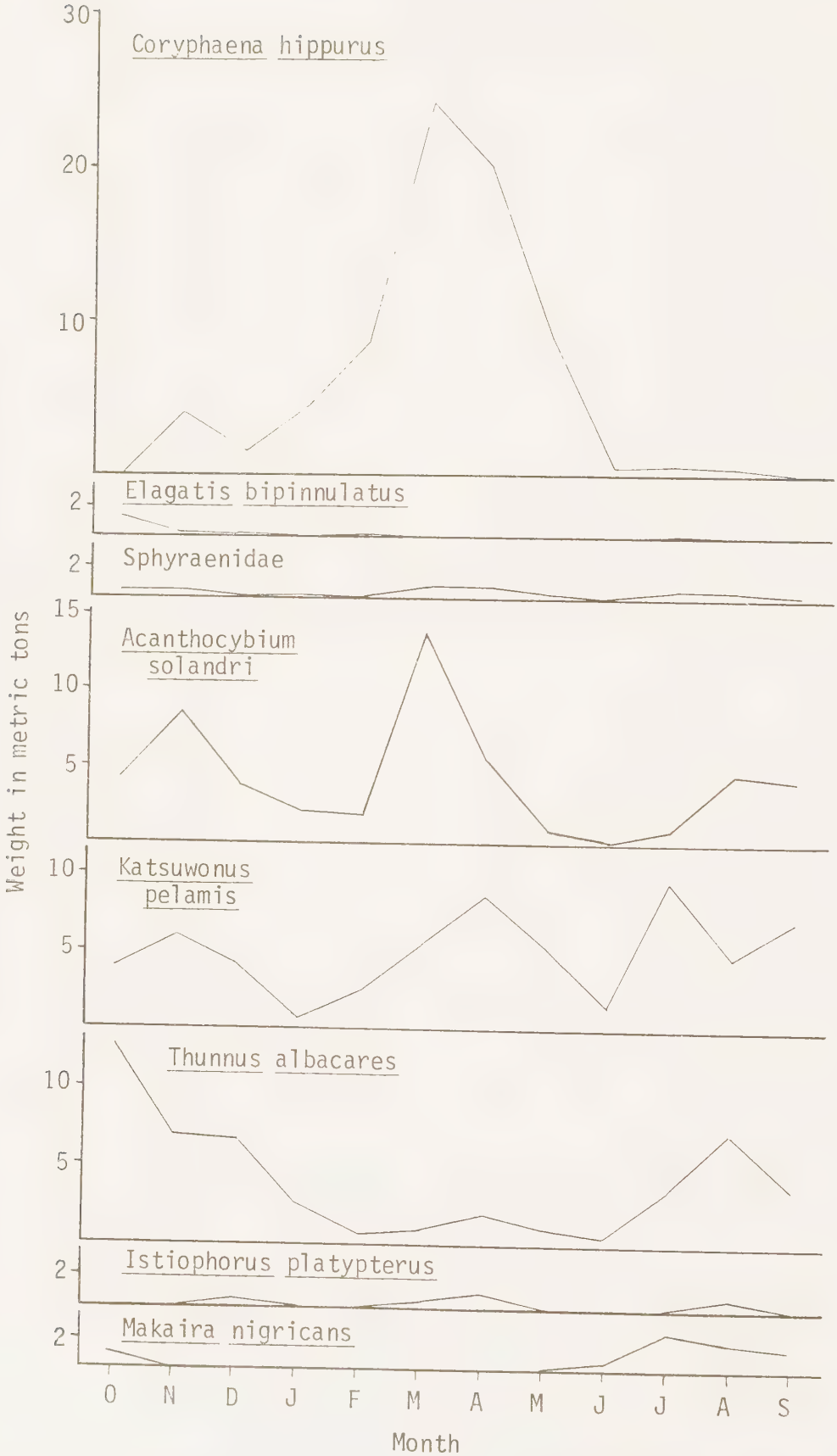


Figure 2. Monthly fluctuations in the estimated catches of major trolled species during FY 83.

Bottomfishing

CPUE and estimated monthly and annual catch and effort are presented in Table 3.

An estimated 20.1 m.t. of bottomfish were landed island-wide during FY 83. Monthly catches ranged from a high of 5.8 m.t. in October to a low of less than 0.1 m.t. in May. Highest catches were in the months of July to October and January (Figure 1). An estimated 7,592 boat hours were spent bottomfishing with a mean CPUE of 2.64 kg/boat-hr. Monthly CPUE ranged from 0.93 kg/boat-hr. in February to 6.07 kg/boat-hr. in October.

As in previous years, the most important bottomfishes were snappers (Family Lutjanidae) which collectively comprised 34.9% of the catch (Table 4). Most were deep-water forms generally caught near the 200 m contour, the most important of which were Onaga (Etelis coruscans), Ehu (E. carbunculus), and various species of Pristipomoides. The most important primarily shallow-water species was the Uku (Aprion virescens). The two next most important families were the emperors (Lethrinidae; 24.3%) and the groupers (Serranidae; 17.4%). The single most important bottomfish species was the red-gilled emperor (Lethrinus rubrioperculatus, "mafute") which accounted for fully 22.0% of the bottomfish catch. The most important groupers were the large, usually rare, Epinephelus septemfasciatus (8.8%), and the common lyretail coral trout (Variola louti; 4.8%)* Carcharhinid sharks accounted for 12.2% of the landed catch, however, this is probably an under-estimate of the actual quantity caught since most fishermen prefer to kill and discard them.

Jacks (Carangidae), goatfishes (Mullidae), wrasses (Labridae), the unicornfish Naso vlamingi (Acanthuridae), and triggerfishes (Balistidae) were landed regularly in small quantities. Most of these are fished for in relatively shallow water less than 200 m in depth.

Spearfishing

Spearfishing was subdivided into two methods - by scuba diving and by snorkeling - which were analyzed separately. CPUE and estimated monthly and annual catch and effort for both methods are presented in Table 5.

*The local grouper landings were undoubtedly influenced by the fortuitous sampling of a few large individuals of E. septemfasciatus, which was not sampled during FY 82 censuses. While generally rare off Guam and its offshore banks, this species is the dominant grouper by weight of catches from the relatively less exploited islands and banks north of Saipan.

Table 3. Offshore creel survey expansion for bottom fishing, monthly summary data, FY 83. Units are the same as in Table 1.

MONTH	MONTHLY CATCH	STD ERR	DF	90% CONF. LMT	MONTHLY EFFORT	STD ERR	DF	90% CONF. LMT	CPUE
OCT	5,798.3	2,764.2	3	6,504.3	954.7	98.3	3	231.4	6.07
NOV	1,040.3	302.9	3	712.7	458.5	103.9	3	244.4	2.27
DEC	913.1	292.6	3	688.5	655.6	170.3	3	400.7	1.39
JAN	3,601.8	3,125.3	3	7,353.8	1,151.7	769.7	3	1,811.1	3.13
FEB	526.9	-	2	-	569.3	-	2	-	.93
MAR	514.5	148.4	3	349.2	426.9	81.4	3	191.4	1.21
APR	835.3	-	2	-	700.8	-	2	-	1.19
MAY	69.1	-	2	-	15.2	-	2	-	4.55
JUN	265.5	229.9	3	540.9	155.0	134.2	3	315.9	1.71
JUL	1,914.7	1,166.4	3	2,744.4	1,124.6	414.2	3	974.6	1.70
AUG	1,849.4	785.8	3	1,849.1	684.5	112.3	3	264.2	2.70
SEP	2,741.3	1,604.1	3	3,774.5	694.8	85.4	3	200.9	3.95
FY'83:	20,070.2	-	-	-	7,591.6	-	-	-	2.64

Table 4. Composition of the FY 83 bottomfish catch by weight. Only taxa accounting for 1% or more of the catch are individually listed.

Family and Species	Weight m.t.	%
Carcharhinidae:	2.4	12.2
Serranidae:	3.5	17.4
Epinephelus fasciatus	0.3	1.7
E. septemfasciatus	1.8	8.8
Variola louti	1.0	4.8
Other spp.	0.4	2.1
Carangidae:	0.4	2.0
Carangoides orthogrammus	0.3	1.4
Other spp.	0.1	0.6
Lutjanidae:	7.0	34.9
Aphareus rutilans	0.3	1.5
Aprion virescens	0.6	3.1
Etelis carbunculus	0.6	3.0
E. coruscans	1.5	7.3
Pristipomoides amoenus	0.2	1.2
P. auricilla	1.3	6.5
P. filamentosus	0.5	2.4
P. flavipinnis	0.3	1.6
P. seiboldi	0.4	1.8
P. zonatus	0.4	2.2
Other spp.	0.3	1.4
Unid. Lutjanids	0.6	2.8
Lethrinidae:	4.9	24.3
Lethrinus rubrioperculatus	4.4	22.0
Other spp.	0.5	2.3
Mullidae:	0.1	0.7
Labridae:	0.2	1.2
Xyrichtys pavo	0.2	1.0
Other spp.	0.1	0.3
Acanthuridae:	0.2	1.1
Balistidae:	0.4	1.9
Sufflamen fraenatus	0.2	1.2
Other spp.	0.1	0.7
Synodontidae, Muraenidae and Holocentridae:	<0.1	0.2
Total	20.1	100.0

Table 5. Offshore creel survey expansion for spearfishing, monthly summary data, FY'83. Units are the same as in Table 1.

	MONTH	MONTHLY CATCH	STD ERR	DF	90% CONF. LMT	MONTHLY EFFORT	STD ERR	DF	90% CONF. LMT	CPUE
SCUBA DIVING	OCT	0	0	3	0	0	0	3	0	-
	NOV	0	0	3	0	0	0	3	0	-
	DEC	42.6	38.5	3	90.6	21.2	19.2	3	45.1	2.01
	JAN	0	0	3	0	0	0	3	0	-
	FEB	315.1	-	2	-	122.8	-	2	-	2.57
	MAR	72.6	69.2	3	162.8	18.8	17.9	3	42.2	3.86
	APR	125.1	-	2	-	43.6	-	2	-	-
	MAY	264.4	-	2	-	70.2	-	2	-	-
	JUN	288.7	275.2	3	647.6	105.6	100.7	3	236.9	2.73
	JUL	0	0	3	0	0	0	3	0	-
	AUG	326.6	282.9	3	665.6	80.3	69.5	3	163.6	4.06
	SEP	0	0	3	0	0	0	3	0	-
	FY'83:	1,229.1	-	-	-	462.5	-	-	-	2.66
SNORKELING	OCT	543.6	362.7	3	853.4	454.2	363.9	3	856.3	1.20
	NOV	21.0	18.7	3	44.1	18.2	16.3	3	38.4	1.15
	DEC	84.7	76.6	3	180.3	24.2	21.9	3	51.5	3.50
	JAN	0	0	3	0	0	0	3	0	-
	FEB	0	0	2	0	0	0	2	0	-
	MAR	63.4	55.9	3	131.6	24.3	21.4	3	50.4	2.61
	APR	0	0	2	0	0	0	2	0	-
	MAY	514.8	-	2	-	70.2	-	2	-	7.33
	JUN	1.6	1.4	3	3.3	23.2	20.1	3	47.3	0.07
	JUL	0	0	3	0	0	0	3	0	-
	AUG	0	0	3	0	0	0	3	0	-
	SEP	0	0	3	0	0	0	3	0	-
	FY'83:	1,435.1	-	-	-	614.3	-	-	-	2.34
Grand total snorkeling & scuba diving		2,664.2	-	-	-	1,076.8	-	-	-	2.47

An estimated 2.7 m.t. of speared fish were landed from small boats operating outside the reef margin during FY 83. Approximately 1.2 m.t. were taken by scuba divers and 1.4 m.t. were taken by snorkelers. An estimated 1,077 boat-hours were spent spearfishing (463 hours by scuba divers; and 614 hours by snorkelers). Mean CPUE for both methods combined was 2.47 kg/boat-hour fished, and was slightly higher for scuba divers (2.66 kg/boat-hr. vs 2.34 kg/boat-hr. for snorkelers). It is difficult to make a valid estimate of the FY 83 spearfishing catch due to the sparcity of data, and biases of the sampling method that remain to be resolved. Additional data on spearfishing activity during non-censused hours will need to be obtained before a more realistic estimate can be made. Since spearfishing parties frequently return late at night, it is believed that current estimates of FY 83, and most earlier years are quite low.

Parrotfishes (Scaridae) and surgeonfishes (Acanthuridae) accounted for nearly half of the spearfishing catch sampled during FY 83 (Table 6). Parrotfishes were the most important family taken by scuba divers while surgeonfishes were the most important family taken by snorkelers. Also among the top ten families taken by offshore spearfishing, listed by order of importance, are Holocentridae, Kyphosidae, Labridae, Serranidae, Lutjanidae, Mullidae, Muraenidae, and Haemulidae. In addition, a small quantity of octopus and spiny lobster were taken. These have not been included in the analysis and will be considered at a later date.

Other Infrequently Encountered Methods

CPUE and estimated annual catch and effort for atulai fishing, longlining, ikashibi fishing, and spin casting for FY 83 are summarized in Table 7.

An estimated 1.2 m.t. of atulai (Selar crumenophthalmus) were taken by jigging with the aid of a night light during FY 83. This estimate, based on only two interviews, is considered low because the current sampling period (1700 to 2100 hr) is biased against night fishing. Most atulai fishermen return in the early morning when the census is not taken.

The FY 83 longline catch estimate of 1.4 m.t. is based on a single interview. Only one boat is known to have practiced longlining during FY 83, and that boat generally returned to port within the sampling period. The longline catch sampled is significant for consisting primarily of albacore (Thunnus alalunga - 69%), a species previously unknown to Guam's fishery. Also represented in the catch were mahimahi, skipjack tuna, and a lancetfish (Alepisaurus borealis), another species new to Guam.

Longlining (as well as ikashibi fishing) opens up a realm previously unexploited by Guam's fishermen by harvesting in open-water depths exceeding 100 m. There, the cooler water temperatures are able to support species like albacore which occur at the surface in warm temperate seas. The FY 83 estimated ikashibi catch of 0.7 m.t. is also based on one interview. This catch consisted entirely of yellowfin tuna, a species known for migrating between surface waters and depths in excess of 100 m.

Table 6. Composition of the FY 83 spearfishing catch by weight.

Family	by Snorkel wt.(kg)	%*	by Scuba wt.(kg)	%*	Total wt.(kg)	%*
Muraenidae			47.4	6.0	47.4	2.6
Holocentridae	40.0	3.9	178.3	22.5	218.3	12.0
Serranidae	9.2	0.9	89.5	11.3	98.7	5.4
Priacanthidae			2.8	0.4	2.8	0.2
Carangidae	16.9	1.6			16.9	0.9
Lutjanidae	58.6	5.7	13.6	1.7	72.2	4.0
Haemulidae			42.7	5.4	42.7	2.3
Lethrinidae	2.5	0.2			2.5	0.1
Mullidae	26.6	2.6	34.3	4.3	60.9	3.3
Pempheridae	7.1	0.7			7.1	0.4
Kyphosidae	159.3	15.4	11.9	1.5	171.2	9.4
Labridae	109.8	10.6	48.7	6.1	158.5	8.7
Scaridae	191.1	18.5	276.8	34.9	467.9	25.6
Acanthuridae	377.2	36.5	46.8	5.9	424.0	23.2
Siganidae	7.1	0.7			7.1	0.4
Bothidae	8.9	0.9			8.9	0.5
Monacanthidae	17.8	1.7			17.8	1.0
Total identif. fishes	1,032.1	99.0	792.8	100.0	1,824.9	100.0
Undifferentiated fishes	197.1	-	642.4	-	839.5	-
Total	1,229.1	-	792.8	-	1,824.9	-

* = % of the identified portion of the catch only.

Table 7. Summary of infrequently encountered fishing methods and their CPUE, catch, and effort during FY 83. These figures are based on the additive total of each monthly analysis. Units are the same as those used in Table 1.

Method	Catch(Kg)	Effort	CPUE
Atulai	1,150.1	518.0	2.22
Longline	1,368.7	141.0	9.7
Ikashibi	707.7	362.9	1.9
Spin Cast	28.9	8.5	3.4

Spin casting from an anchored boat was also encountered only once during FY 83. One fish, the needlefish Tylosurus crocodilis crocodilis was taken. Spin casting with light tackle undoubtedly occurs more frequently than indicated, but may be inadvertently combined with other methods (such as bottomfishing with the same equipment); or overlooked (boating parties primarily enganged in non-fishing activities may briefly use light tackle and not inform the interviewer).

Overview

An estimated 275.4 m.t. (90% c.l. = 42.1 m.t.*) of finfish were landed island-wide by boats utilizing a variety of methods beyond the reef during FY 83 (Table 8). An estimated 7,469 boat trips were made in which 47,104 boat-hours were spent fishing. Mean daily participation was estimated at 16.3 boats per weekday and 30.2 boats per weekend day or holiday. Monthly CPUE (kg/boat-hour fished) ranged from a low of 2.07 in June to a high of 8.75 in April, with a monthly average of 5.85. The best fishing months were March and April while the worst fishing was June. Trolling accounted for 90.6% of the catch (249.4 m.t.; 90% c.l. = 41.6%) while bottomfishing accounted for 7.3% of the catch (20.1 m.t.; 90% c.l. = 8.4) and all other methods combined accounted for 2.1% (5.9 m.t.) of the catch.

The total offshore estimate derived from the FY 83 creel census effort represents a 90% increase over that for FY 82. We attribute this primarily to a more accurate assessment of offshore participation made in FY 83. For the sake of comparison, a simple reanalysis of FY 82 data, utilizing the more realistic participation ratio found between the Agana Boat Basin and the other island-wide launching areas, was performed. The outcome of this was an estimated total offshore harvest for FY 82 of 275.3 m.t., nearly identical to that of FY 83. For the two most frequently sampled fishing methods the FY 82 reestimates were as follows: trolling = 240.6 m.t. at 6.58 kg/boat-hour; bottomfishing = 32.2 m.t. at 3.45 kg/boat-hour.

RECOMMENDATIONS

The FY 83 offshore census was designed to be a random sample. However, due to personnel limitations, it was not possible to randomize the census over a 24 hr. period, nor was it possible to sample an entire 24 hour period. Therefore, the foregoing analysis is biased toward the methods of fishing most frequently engaged in by boats returning during the census period (1700 to 2100 hrs.). In order to correct this, it will be necessary to more accurrately determine the relative frequencies of various fishing methods engaged in by boats returning at different times of the day. Since most boats returning within the census period engaged in trolling, and a lesser percentage engaged in bottomfishing, spearfishing, atulai fishing and

*All annual confidence limits are based on the less accurate annual expansion derived from 45 sample days (Table 8B).

Table 8. Summary of offshore creel survey expansion for FY 83.

A. Summary data by month: the resulting total for FY 83 is the additive total of monthly catch, effort, and participation for all fishing methods combined. Catch is in Kg., effort in boat-hours fished, and CPUE in Kg/boat-hour fished.

MONTH	MONTHLY CATCH	STD ERR	DF	90% CONF. LMT	MONTHLY EFFORT	STD ERR	DF	90% CONF. LMT	CPUE	MONTHLY PARTIC.	STD ERR	DF	90% CONF. LMT
OCT	32,470.9	5,218.0	3	12,277.9	6,205.8	1,365.0	3	3,211.8	5.23	863.3	74.5	3	175.3
NOV	26,578.9	4,759.0	3	11,197.8	3,940.7	675.5	3	1,589.4	6.74	623.0	128.1	3	301.4
DEC	19,821.4	4,655.3	3	10,953.8	3,655.0	481.8	3	1,133.6	5.42	572.5	109.2	3	256.9
JAN	13,382.4	6,065.4	3	14,271.9	2,503.4	873.8	3	2,056.1	5.35	440.2	113.5	3	267.0
FEB	13,709.3	-	2	-	3,645.4	-	2	-	3.76	625.2	-	2	-
MAR	46,075.5	2,795.9	3	6,578.9	5,848.6	794.3	3	1,869.0	7.88	955.7	89.2	3	209.8
APR	40,105.3	-	2	-	4,586.0	-	2	-	8.75	606.5	-	2	-
MAY	17,121.4	-	2	-	2,406.4	-	2	-	7.11	450.3	-	2	-
JUN	3,670.9	1,557.9	3	3,665.8	1,776.7	403.5	3	949.3	2.07	353.6	36.3	3	85.4
JUL	19,439.8	2,972.5	3	6,994.2	4,896.3	36.3	3	85.3	3.97	722.4	26.3	3	61.8
AUG	23,595.3	3,509.6	3	8,258.2	3,733.3	273.6	3	643.8	6.27	600.3	45.2	3	106.4
SEP	19,398.9	7,371.1	3	1,7344.1	3,906.1	1091.7	3	2568.7	4.97	656.0	24.5	3	57.5
FY 83:	275,370.0	-	-	-	47,103.7	-	-	-	5.85	7,469.0	-	-	-

B. Summary data based on 22 WE/H and 24 WD samples not broken down by month. This method permits the determination of annual standard errors and confidence limits but the catch, effort and participation estimates are not as accurate as those given above due to differences in month lengths and rounding errors.

GEAR	PERIOD CATCH	STD ERR	DF	90% CONF. LMT	PERIOD EFFORT	STD ERR	DF	90% CONF. LMT	CPUE
TROL	239,165.2	24,535.3	34	41,636.5	37,596.9	2,524.4	34	4,284.0	6.36
BOTM	20,681.9	4,928.9	34	8,364.3	7,535.2	1,079.9	34	1,832.5	2.74
ATUL	672.6	487.9	34	827.9	325.4	217.1	34	368.4	2.07
SPSN	1,232.1	599.2	34	1,016.8	592.8	330.9	34	561.5	3.41
SPSC	1,723.6	707.8	34	1,201.2	559.9	237.5	34	403.0	3.08
LGLN	1,346.1	1,215.3	34	2,062.4	138.7	125.3	34	212.6	9.71
IKAS	763.5	725.3	34	1,230.9	391.6	372.0	34	631.2	1.95
OTHR	34.7	31.4	34	53.2	10.2	9.2	34	15.6	3.40
TOT:	265,619.8	24,787.0	34	42,063.6	47,150.6	3,004.7	34	5,099.0	5.63

PERIOD PARTICIPATION: 7,587.6 STD ERR: 376.3 90% CONF. LMT: 638.6

perhaps other methods, it is likely that the current estimate of the trolling catch is slightly high, while those of other methods are too low.

Beginning in FY 84, the census period at the Agana Boat Basin will be extended to 1300 hours. If personnel are available, a separate study will be conducted to determine the extent of temporal differences in the relative frequencies of fishing methods engaged in by returning boats. In addition, we expect the computer program to be modified to permit differential expansion by method. Although the FY 83 expansion is an improvement over that of previous years, the results may be modified pending the outcome of differential expansions by fishing method.

Report prepared by Robert F. Myers and Evangeline T. Charfauros

PROJECT TITLE: Seventh Annual Marianas Fishing Derby

PERIOD COVERED: July 16-18, 1983

INTRODUCTION

The Seventh Annual Marianas Fishing Derby (MFD) sponsored by the Guam Fishing and Boating Association was held on July 16, 17 and 18, 1983. The organizational efforts of the Derby Committee chaired by Mr. Steven W. Philips made this year's event a great success. The Aquatic and Wildlife Resources fisheries biologists wish to thank the committee for their assistance and the fishermen for their cooperation in providing catch information. This coordination helped make our job easier and more enjoyable.

There were four classes of fish and seven prize categories. Awards were presented to the fishermen who landed the first, second and third heaviest fish of the following four species: blue marlin (Makaira nigricans), yellowfin tuna (Thunnus albacares), wahoo (Achanthocybium solandri) and mahimahi (Coryphaena hippurus). As in the past an award was also presented for the greatest 3-day total number of all above categories. This year prizes were awarded for the largest fish caught in a ladies category and in a children under age 16 category. Additionally, records were kept in an "other species" category.

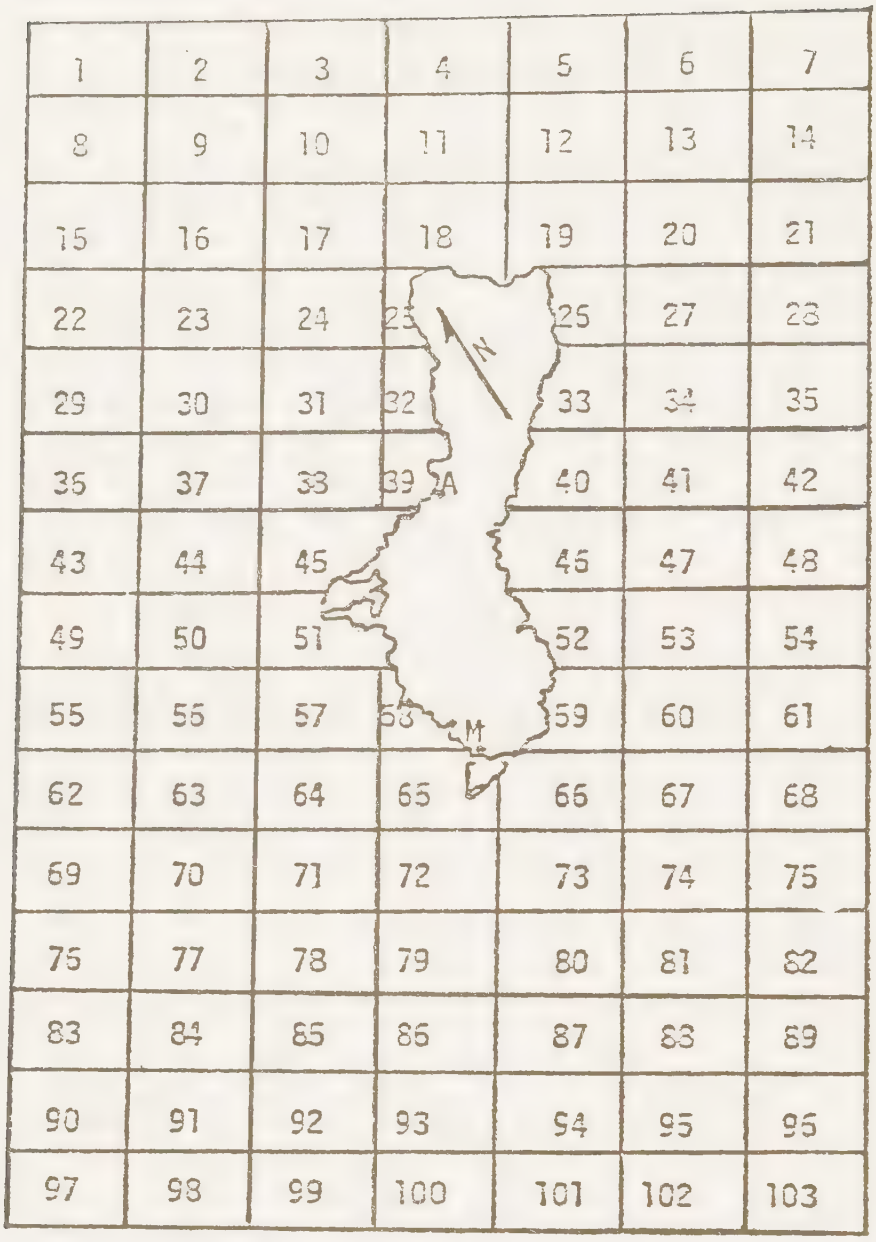
PARTICIPATION

For the third successive year, onshore derby stations were set up at the Agana Boat Basin and the Merizo Pier (Figure 1). Daily participation information is listed in Table 1. A total of 160 boat trips, averaging 7.6 hours per trip, were made. Of these 72.5% (116) originated at the Agana Boat Basin and 44 originated in Merizo. Each boat carried an average of 2.8 anglers per trip and pulled an average of 4.1 lines. Participation was down slightly from last year but still reflects the trend of increasing participation through the Derby's history (Figures 2 and 3).

The mean length of fishing trip made during the 1983 Derby (7.6 hrs.) was less than that of last year's Derby (Figure 4). Since the 1981 Derby mean trip length has decreased. This year's Derby anglers spent an estimated 3442.8 person-hours of fishing effort. "Soaking time" or the amount of time lines were trolled amounted to 4768.2 line-hours. The average time lost per fishing trip was 1.5 hrs.

THE CATCH

A total of 281 fish weighing 3277.6 kg was reported for the 1983 MFD. This total comprises the four main derby species as well as the "other species" category. Table 2 presents the 1983 MFD catch record by date and check-in location. More mahimahi (33) were caught this year than during all pervious derbies combined. No other catch records were set. The mean catch per boat trip was 20.5 kg. This is greater than last year's mean catch rate. Figure 5 illustrates the mean catch rate in kg for all



FISHING AREA NUMBERS:
FILL IN ON OTHER SIDE
GRID SCALE:
APPROX. 5 mi. x .8 mi.
4 = Rota Bank
12 = 45º Bank
24/25 = Ritidian Pt.
19 = Pati Pt.
33 = Hospital Pt.
51 = Orote Pt.
70 = 11mi. (17mi.) Reef
85 = Galvez Bank
92 = Baby Banks
100 = Santa Rosa Reef

Figure 1. The island of Guam with MFD fishing areas.
A = Agana Boat Basin; M = Merizo Pier.

Table 1. Daily participation in the 1983 Marianas Fishing Derby (MFD).

Date	No. Boats	No. Trips	Avg. Trip Hrs.	No. Persons	Avg. Pers/Trip	No. Lines	Avg. Lines/Trip
Agana							
July 16	46	48	6.1	132	3.0	211	4.4
July 17	37	37	8.5	108	2.9	143	3.9
July 18	31	31	6.6	85	2.7	125	4.3
Total	114	116	7.1	325	2.8	479	4.1
Merizo							
July 16	14	14	10.7	48	3.4	66	4.7
July 17	18	18	10.3	54	3.0	76	4.2
July 18	11	12	7.4	29	2.4	29	4.4
Total	43	44	9.5	131	2.9	171	3.9
Combined Total	157	160	7.6	456	2.8	650	4.1

Table 2. Daily catch for the 1983 MFD.

Date	Blue Marlin		Yellowfin		Wahoo		Mahimahi		Other Species		Total	
	No.	Kg	No.	Kg	No.	Kg	No.	Kg	No.	Kg	No.	Kg
Agana												
July 16	5	377.7	26	386.6	12	117.2	1	5.7	70	532.1	114	1419.3
July 17	3	289.5	14	167.0	3	43.0	4	33.2	5	21.2	29	553.9
July 18	3	191.0	8	116.2	0	-	2	11.4	1	8.2	14	326.8
Total	11	858.2	48	669.8	15	160.2	7	50.3	76	561.5	157	2300.0
Merizo												
July 16	1	52.3	36	283.6	8	82.4	5	24.1	1	6.8	51	449.2
July 17	1	53.6	11	122.3	8	82.3	5	32.6	11	37.4	36	328.2
July 18	0	-	5	30.0	5	34.8	16	88.2	11	47.2	37	200.2
Total	2	105.9	52	435.9	21	199.5	26	144.9	23	91.4	124	977.6
Combined Total	13	964.1	100	1105.7	36	359.7	33	195.2	99	652.9	281	3277.6

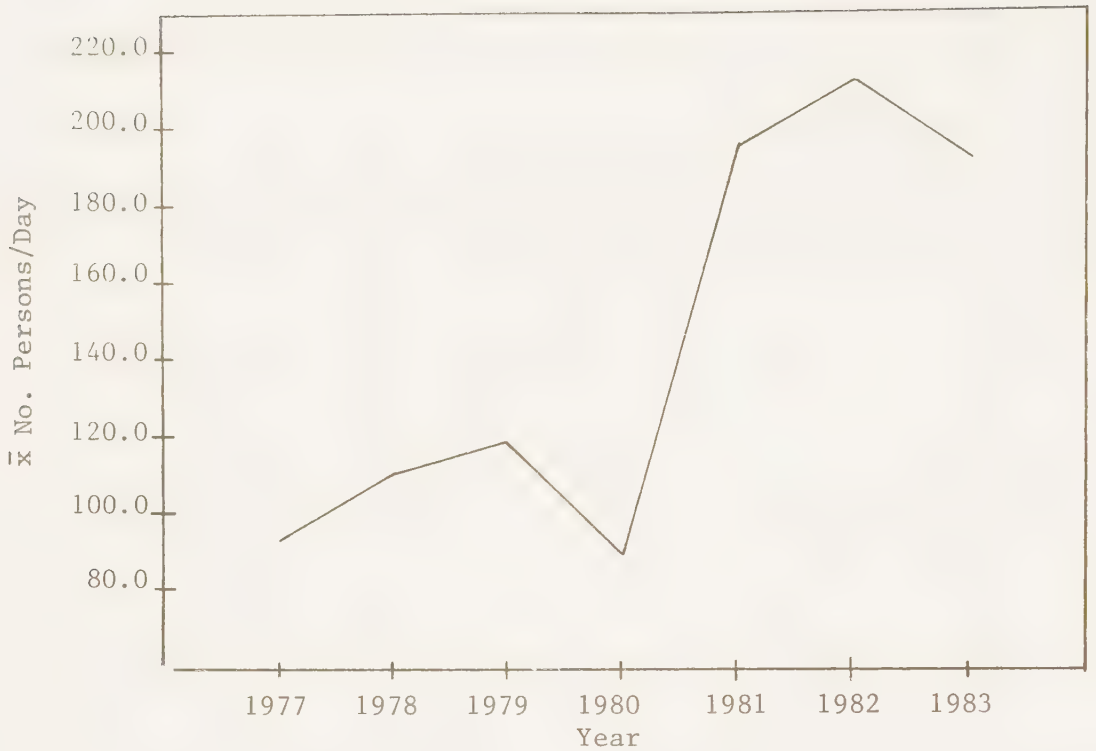


Figure 2. Mean daily participation for the derby.

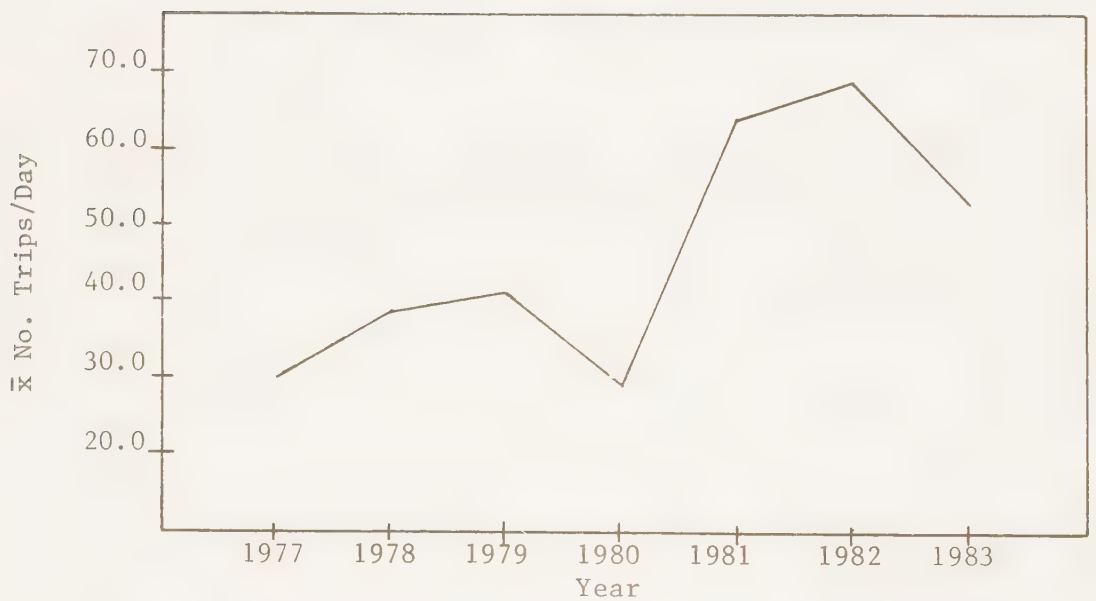


Figure 3. Mean daily No. of boats for the derby.

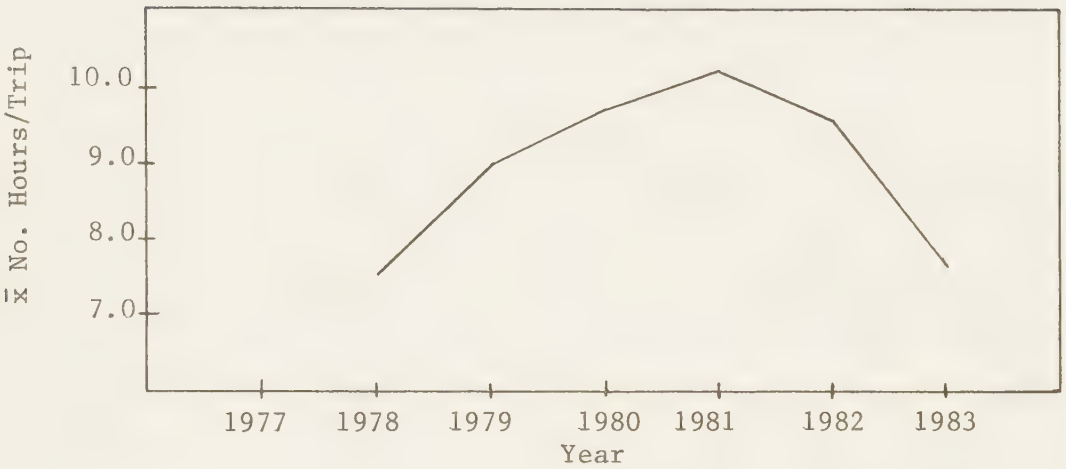


Figure 4. Seven-year mean lengths (Hr.) per boat trip for the derby (no data available for 1977).

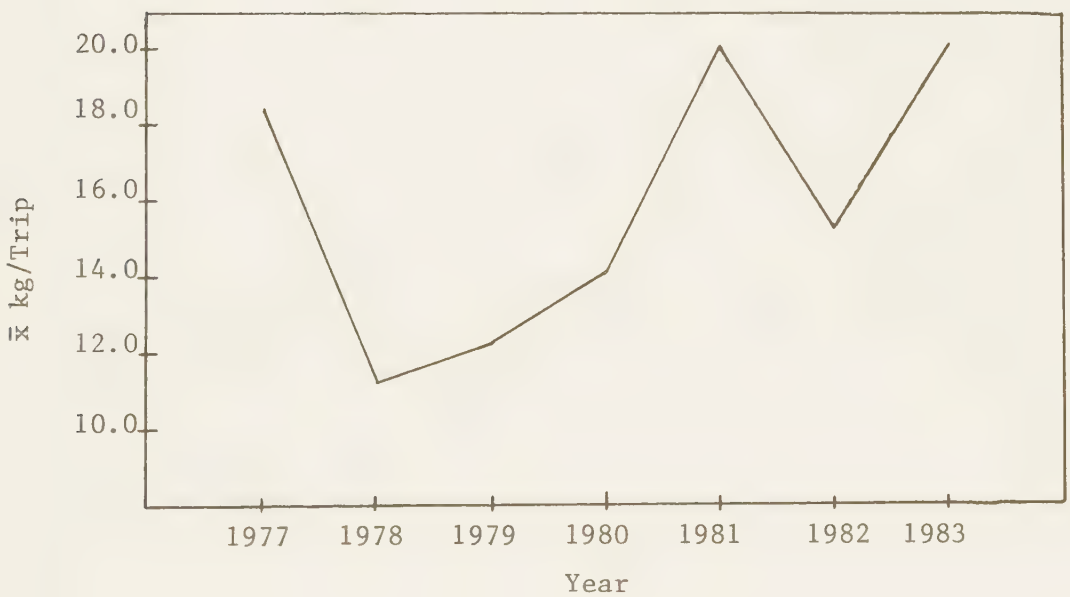


Figure 5. Seven-year mean catch (kg) per boat trip for the derby.

seven derbies. The catch comparisons among the four principal species for all Marianas Fishing Derbies is presented in Table 3. The mean weights recorded for these species are illustrated in Figures 6 and 7.

Thirteen blue marlin were caught this year. The total weight was 964.1 kg with a weight range between 19.2 and 199.1 kg. The mean weight was 74.2 kg.

The yellowfin tuna catch numbered 100 individuals weighing 1105.7 kg. The weights ranged between 4.3 and 55.7 kg with a mean weight of 11.1 kg.

A total of 36 wahoo were landed which is also less than last year's wahoo catch. The total weight was 359.7 kg with a range between 6.4 and 24.5 kg. The mean weight was 10.0 kg.

Thirty-three mahimahi were landed this year. This is more than twice the 1982 record of 14 fish and greater than six times the mahimahi catch of any other individual derby. The total weight was 195.2 kg with a range between 1.5 and 11.1 Kg. The mean weight was 5.9 kg.

The "other species" category included 99 fish weighing a total of 652.9 kg. Included in this total were 85 skipjack tuna (Katsuwonus pelamis) (569.5 kg; 87.2%), eight barracuda (Sphyraena barracuda) (44.5 kg; 6.8%), four rainbow runners (Elagatis bipinnulatus) (7.3 kg; 1.2%), one sailfish (Istiophorus platypterus) (24.8 kg; 3.8%), and one dogtooth tuna (Gymnosarda unicolor) (6.8 kg; 1.0%).

FISHING AREA

Table 4 presents the 1983 MFD catch record by date, species and strike area. A complete guide to fishing areas is presented in Figure 1.

As in the 1981 and 1982 derbies, the greatest numbers and weight of fish were caught in Guam's southern waters. The most productive spot was the Galvez Bank (Area #85). The greatest number of fish caught during a single boat trip (14 mahimahi) was landed in Area #51 off Orote Point. The prize winning wahoo and mahimahi were caught in Areas #78 and #51, respectively. Prizes for the largest marlin and yellowfin tuna went for fish caught in the north. The highest percentages by number and weight were taken from Galvez Bank (19.8% and 15.4%), Rota Banks (21.4% and 10.6%), Orote Point (13.4% and 7.6%) and the Baby Banks - Santa Rosa Reef vicinity (5.3% and 1.7%). Unfortunately, not all fishermen reported the strike area therefore, these values are low estimates of the actual catch per area. Additionally, the greatest effort per area cannot be computed since the fishing areas for no catch trips were not reported.

FEEDING BEHAVIOR OF DERBY FISHES

A total of nine blue marlin, three yellowfin, eight wahoo and four mahimahi were dissected for stomach content analysis (Table 5). All but one of the marlin contained recognizable prey.

Table 3. CATCH COMPARISONS FOR ALL MARIANAS FISHING DERBIES*
Weights are expressed in kilograms (1 kg = 2.2 lbs)

	1977	1978	1979	1980	1981	1982	1983
MARLIN							
no. caught	9	9	6	12	34	12	13
total weight (kg)	933.0	511.0	703.0	727.0	2005.0	852.0	964.1
avg. weight (kg)	104.0	56.8	117.0	60.6	59.0	71.0	74.2
winning fish (kg)	192.0	75.2	238.0	139.0	145.0	132.0	199.1
YELLOWFIN							
no. caught	18**	11	34	50	109	205	100
total weight (kg)	240.0	255.0	637.0	308.0	1156.0	2377.0	1105.7
avg. weight (kg)	8.4	23.2	18.7	6.2	10.6	11.6	11.1
winning fish (kg)	46.3	56.8	67.7	51.1	47.7	61.1	55.7
WAHOO							
no. caught	7	9	11	12	33	60	36
total weight (kg)	90.9	102.0	116.0	161.0	543.0	264.0	359.7
avg. weight (kg)	10.0	11.4	10.5	13.4	9.0	8.0	10.0
winning fish (kg)	22.3	18.9	19.7	23.4	17.0	22.7	24.5
MAHIMAHI							
no. caught	2	4	5	3	1	14	33
total weight (kg)	13.6	26.4	52.6	39.3	0.8	63.7	195.2
avg. weight (kg)	6.8	6.6	10.5	13.1	-	4.6	5.9
winning fish (kg)	8.9	8.9	14.8	15.9	0.8	14.8	11.1
TOTAL CATCH							
no. caught	36	33	56	77	177	264	182
total weight (kg)	1277.0	895.0	1508.0	1235.0	3705.0	3029.0	2624.7

* Based on returned catch reports. Only the principal derby species are included.
** Includes all tuna species.

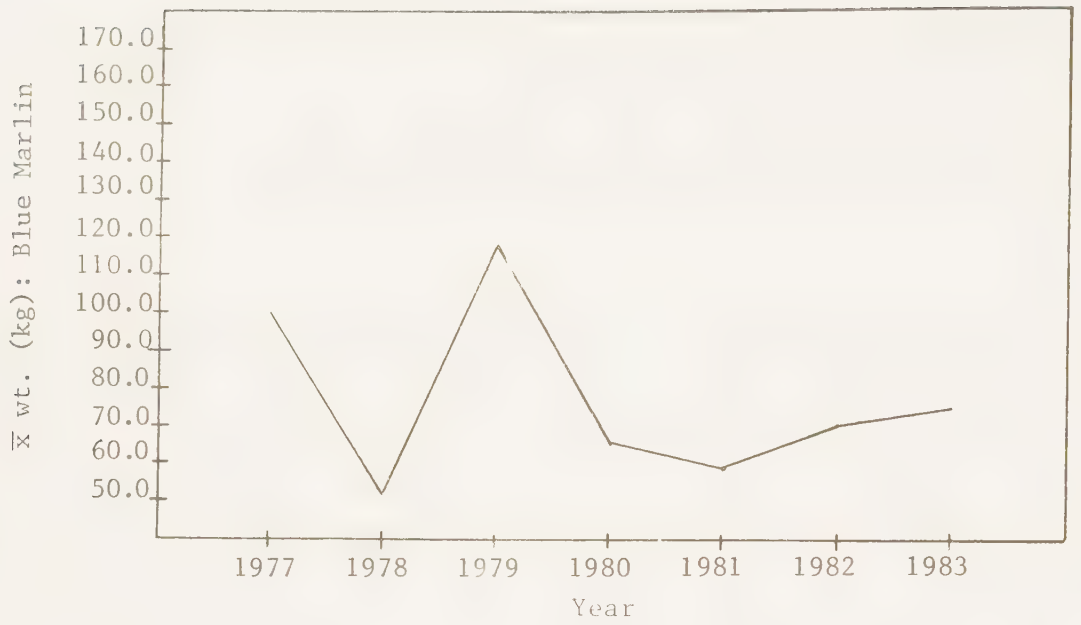


Figure 6. Seven-year derby mean weights (kg) of blue marlin.

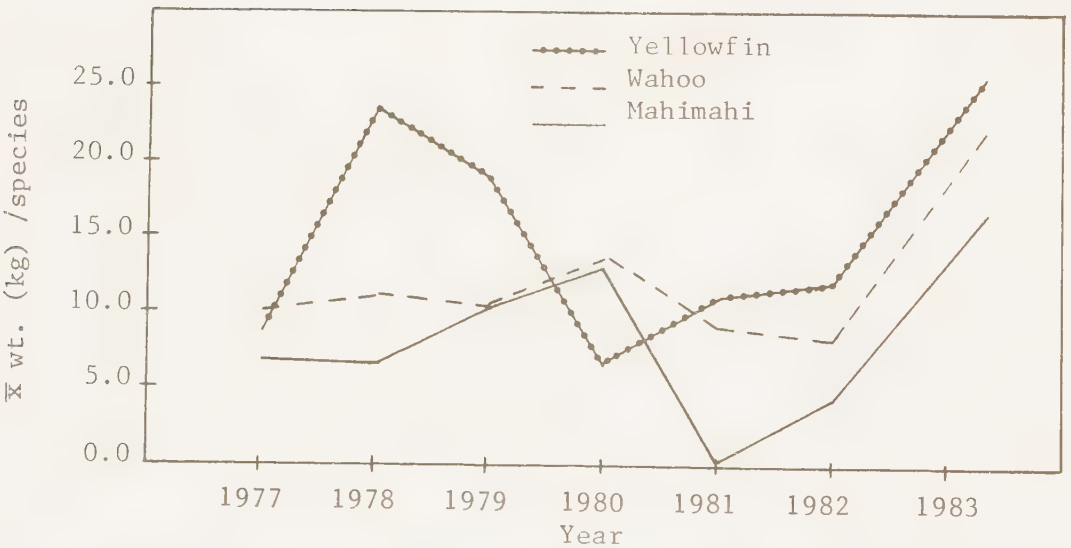


Figure 7. Seven-year derby mean weights (kg) of yellowfin tuna, wahoo and mahimahi.

Table 4. Number of fish caught during the 1983 MFD by species, date and catch area (see also Figure 1). This table includes only those fishes for which area data were recorded.

AREAS	3	4	5	6	12	17	18	19	24	25	29	30	32	33
Blue Marlin														
July 16	1	1							1					
July 17	1											1		
July 18									1					1
Σ	2	1							2			1		1
$\bar{x}$wt	109.7	57.3							73.9			42.7		72.7
Yellowfin														
July 16		9	2	2			1	2	5					
July 17		3				2								
July 18		3			1			2						
Σ		15	2	2	1	2	1	4	5					
$\bar{x}$wt		20.1	9.5	11.5	55.7	11.5	11.5	29.3	11.5					
Wahoo														
July 16		2	1			1	3			2				
July 17														
July 18														
Σ		2	1			1	3			2				
$\bar{x}$wt		11.1	15.0			7.0	8.9			9.5				
Mahimahi														
July 16								1						
July 17							1				1		1	
July 18								1						
Σ							1	2			1		1	
$\bar{x}$wt							5.5	5.1			7.0		9.5	
Other species														
July 16	1	21	5	4										
July 17		1												
July 18					1									
Σ	1	22	5	4	1									
$\bar{x}$wt	18.5	3.9	1.6	3.6	8.2									
Totals														
No. caught	3	40	8	6	2	3	5	6	7	2	1	1	1	1
% Total No.	1.6	21.4	4.5	3.2	1.1	1.6	2.7	3.2	3.7	1.1	0.5	0.5	0.5	0.5
kg caught	237.9	224.8	42.2	37.4	64.9	30.0	43.6	126.3	205.7	19.1	7.0	42.7	9.5	72.7
% Total kg	10.3	9.3	1.8	1.6	2.8	1.3	1.9	5.0	8.7	0.8	0.3	1.8	0.4	3.1

Table 4a. Continued

AREAS	38	45	51	58	59	65	70	71	72	78	85	92	99	Total
Blue Marlin														
July 16	1		1								1			6
July 17												1		3
July 18		1												3
$\bar{\varepsilon}$	1	1	1								1	1		12
$\bar{x}$wt	145.9	44.1	58.6								52.3	53.6		76.4
Yellowfin														
July 16	1	1									19		8	50
July 17		1				1	1				4	2		14
July 18							4				1			11
$\bar{\varepsilon}$	1	2				1	5				24	2	8	75
$\bar{x}$wt	51.1	53.6				29.5	10.6				12.8	12.3	4.5	10.7
Wahoo														
July 16										1	9			19
July 17				1		3		1			2	1		8
July 18											1			1
$\bar{\varepsilon}$				1		3		1		1	12	1		28
$\bar{x}$wt				14.5		9.7		9.5		24.5	8.2	8.2		10.0
Mahimahi														
July 16			5											6
July 17			4						1					8
July 18			14											15
$\bar{\varepsilon}$			23						1					29
$\bar{x}$wt			5.2						9.1					17.6
Other species														
July 16													1	32
July 17					5									6
July 18						2								3
$\bar{\varepsilon}$					5	2							1	41
$\bar{x}$wt					3.8	17.2							6.8	3.6
Totals														
No. caught	2	3	24	1	5	6	5	1	1	1	37	4	9	185
% Total No.	1.1	1.6	13.4	0.5	2.7	3.2	2.7	0.5	0.5	0.5	19.8	2.1	5.3	100
kg caught	197.0	97.7	179.1	14.5	19.1	92.9	53.3	9.5	9.1	24.5	406.1	86.3	43.2	2313.0
% Total kg	8.5	4.2	7.2	0.6	0.8	3.6	2.0	0.4	0.4	1.0	16.6	3.7	1.9	100.0

Table 5. Summary of stomach contents of 1983 MFD fishes*

	n	Fishes		Crustaceans		Cephalopods	
		% occ.	% wt.	% occ.	% wt.	% occ.	% wt.
Blue Marlin	9	78	92.4	11	0.3	67	7.3
Yellowfin tuna	3	100	35.0	100	63.3	100	1.7
Wahoo	8	100	99.4	0	0.0	25	0.6
Mahimahi	4	100	56.3	50	42.1	50	1.6

*% occ. = % of individuals containing this prey. % wt. = % of total weight of prey in this species.

Marlin fed primarily on fishes, and to a minor extent on squid. Major prey included small tunas, a needle fish and juvenile reef-associated fishes such as triggerfishes, surgeonfishes and jacks. Wahoo fed almost exclusively on fishes, primarily the same kinds fed upon by marlin. Yellowfin fed mostly on pelagic crustaceans and fishes such as mantis shrimp larvae and juvenile boxfishes. Mahimahi fed mostly on fishes, particularly post-larval goatfishes (tiao) and triggerfishes. However, one of the four mahimahi had fed almost exclusively on larval mantis shrimps, a prey it usually does not exploit.

Feeding Behavior section by: Robert F. Myers
Report prepared by: Gretchen R. Grimm

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: TERRITORY OF GUAM

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 2

JOB TITLE: Inshore Creel Censusus

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Inshore creel census interviews were conducted monthly along most of Guam's relatively accessible shoreline from October 1982 through September 1983. From the survey an estimated 37,136 Kg of inshore reef-fish were caught during the year. Surround netting was the most popular inshore method, accounting for over 34% of the total estimated inshore effort in terms of person-hours. Surround netting also yielded over 59% of the estimated total harvest by weight. Other major inshore fishing methods encountered during FY 83 included cast netting, gill netting, spearfishing, and fishing with gaffs and hooks, primarily for octopus. In addition to the harvest made through the use of these methods, an estimated 14,892 Kg were harvested inshore from the Merizo/ Cocos Lagoon region. Therefore, the total inshore harvest for Guam during FY 83 is estimated to be approximately 52,028 Kg.

BACKGROUND

Effective management of the island's inshore fishery resources requires accumulating data on fishing pressure, fishing methods and annual harvest. To this end, the Division of Aquatic and Wildlife Resources has been conducting interviews with inshore fishermen for the past nineteen years.

OBJECTIVES

I. To monitor monthly and annual fluctuations in participation, effort and catch among Guam's most important inshore recreational/subsistence fishing methods.

II. To make monthly and annual estimates of the total inshore reef-fish catch for Guam.

III. To chart variations in catch composition and species distribution patterns for various areas, and to determine it these variations occur in a seasonal or otherwise predictable manner.

IV. To create a table of length/weight conversion constants for Guam's most popular inshore reef-fishes.

PROCEDURES

Starting in FY 83, inshore fisheries data collection was divided into two parts. During each month, fishing participation was surveyed on seven days while catch and effort were surveyed on three days, except when prevented by weather conditions or personnel shortages. Each participation census day entailed surveying fishing activities throughout all three of DAWR's traditional inshore regions while driving once through the entire area (Figure 1). Specific location codes were assigned to relatively small increments of coastline encompassed from the beginning of Region 1 (Fafai Beach) through the end of Region 3 (Pago Bay). The starting point for each participation survey then alternated between the beginning and ending location code areas and the survey usually lasted an average of seven hours. These surveys were made on four weekdays and three weekend days or holidays each month. On each catch and effort survey day fishers within one of the three survey regions were interviewed over a six-hour period. An attempt was made to collect as many "completed-trip" interviews as possible while "near-completed" trip interviews were secondarily preferred. Each route was surveyed once a month, two on weekdays and one on a holiday (including weekends). This allowed each region to be surveyed once on a holiday every three months.

ANALYSIS

The following formulae were applied to the inshore creel census data in order to derive monthly estimates of participation, effort and catch:

Participation

$$P/mo = (P_{wc} \times T_w) \times 16 + (P_{hc} \times T_h) \times 8$$

$$T/mo = \frac{(P_{wc} \times T_w) \times 16}{P_{wt}} + \frac{(P_{hc} \times T_h) \times 8}{P_{ht}}$$

Effort

$$P\text{-}H/mo = \left[\frac{(P_{wc} \times T_w) \times 16}{P_{wt}}\right] P\text{-}H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 8}{P_{ht}}\right] P\text{-}H_{ht}$$

$$G\text{-}H/mo = \left[\frac{(P_{wc} \times T_w) \times 16}{P_{wt}}\right] G\text{-}H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 8}{P_{ht}}\right] G\text{-}H_{ht}$$

Catch

$$Kg/mo = \left(\left[\frac{(P_{wc} \times T_w) \times 16}{P_{wt}}\right] G\text{-}H_{wt} + \left[\frac{(P_{hc} \times T_h) \times 8}{P_{ht}}\right] G\text{-}H_{ht}\right) Kg/G\text{-}H$$

Where P/mo is the estimated number of persons per month,

T/mo is the estimated number of fishing trips per month,

Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows: Region #1 - Fafai Beach to Adelup Pt.
Region #2 - Adelup Pt. to Nimitz Beach
Region #3 - Toguan Bay to Pago Bay

T_w is the mean number of fishing trips per weekday and is calculated by the formula:

$$T_w = \frac{\text{No. daytime fishing hours (See Table 1)}}{\bar{x} \text{ number hours per weekday trip,}}$$

T_h is the mean number of fishing trips per holiday (including weekends) and is calculated similar to T_w,

P_{wc} is the mean number of persons seen per weekday census,

P_{hc} is the mean number of persons seen per holiday census,

16 is the number of fishable weekdays per month and is subjectively calculated by the formula:

$$16 = \frac{(365 \text{ days/yr} \times 0.67) \times 0.80}{12 \text{ mo/yr}},$$

8 is the number of fishable holidays per month and is subjectively calculated by the formula:

$$8 = \frac{(365 \text{ days/yr} \times 0.33) \times 0.80}{12 \text{ mo/yr}},$$

P_{wt} is the mean number of persons censused per weekday fishing trip,

P_{ht} is the mean number of persons censused per holiday fishing trip,

P-H/mo is the estimated number of person-hours per month,

$P\text{-}H_{wt}$ is the mean number of person-hours per weekday fishing trip,

$P\text{-}H_{ht}$ is the mean number of person-hours per holiday fishing trip,

G-H/mo is the estimated number of gear-hours per month,

$G\text{-}H_{wt}$ is the mean number of gear-hours per weekday fishing trip,

$G\text{-}H_{ht}$ is the mean number of gear-hours per holiday fishing trip,

Kg/G-H is the mean catch per unit effort value in kilograms of fish per gear-hour.

Table 1 displays the values used to adjust for seasonal variations in the length of time suitable for fishing during the daylight period among the various inshore fishing methods. These values are subjectively based on

Table 1. Estimated number of possible fishing hours per day for various inshore fishing methods.

Method	Possible Fishing Hours per day	
	Summer	Winter
Hook and Line	12	12
Cast Net	12	12
Gill Net	8	12
Surround Net	8	12
Spearfishing w/Snorkel	12	12
Spearfishing w/SCUBA	12	12
Octopus Fishing	6	4
Mollusk Collecting	4	2

the limitations that tidal fluctuations place upon each method. To explain briefly, the year was divided into two six-month periods (summer and winter). The summer months include April to September while winter months consist of October to March. Changes in diurnal tidal fluctuations found throughout the year at Guam roughly correspond to the summer and winter time periods, with the lowest tides occurring during the day in the summer and at night during the winter. Initially, each inshore fishing method was assigned a maximum fishing time span of 12 hrs per day based on the average length of the daylight period in the tropics. This time span was then reduced for a particular method if it was considered tide-dependant based on observations made by staff fisheries biologists. By doing this, each fishing method could be assessed individually for fishing done throughout the day during both winter and summer tidal seasons.

The numbers of fishable weekdays and holidays in a month was subjectively assessed on an 80% basis. To be more exact, this assessment should be done individually for each month based on actual monthly dates and weather patterns. Since FY 83 was a relatively benign period our estimates should be regarded as minimums.

RESULTS

The major inshore fishing methods censused during FY 83 include hook and line fishing, cast netting, gill netting, surround netting, spearfishing with snorkel, spearfishing with SCUBA, and gaff and hook fishing. In addition, lobsters, crabs, echinoderms and mollusks were harvested with a variety of gear which included hooks, short spears, gardening tools, prybars and hands.

Monthly and annual estimates of inshore fishing participation, effort and catch for FY 83 are displayed in Tables 2-9. Monthly values represent the sums of data expanded separately for both weekdays and holidays in each month. These estimates do not account for fishing that occurred in uncensused areas, at night, or illegally through the use of poisons or explosives. Table 10 summarizes the expanded monthly and annual participation, effort and catch data by fishing method for FY 83. These data are expressed graphically in Figures 2 through 8.

A minimum total estimate of 37,136 Kg of fish were caught through the use of all seven of the major inshore fishing methods in FY 83 (Table 10). This catch resulted from a total effort of 68,143 person-hours or 36,973 gear-hours. Over 100 species of fish from 45 families were represented in the catch. However, surgeonfish (Acanthuridae), jacks (Carangidae), rabbitfish (Siganidae), goatfish (Mullidae), and mullet (Mugilidae) were by far the most abundant.

The most popular fishing method was surround netting in which an estimated 5460 persons (21.9%) participated. Two other methods that were also very popular were cast netting and gill netting with 18.1% and 15.1% of the total estimated participation, respectively. Participation estimates for all seven fishing methods appear in Table 10. The percentage values on this table involve only the seven primary inshore fishing methods.

Table 2. Hook and Line Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	92	600	542	0.05	27
November	315	415	415	0.47	195
December	242	1078	1024	0.21	215
January	235	942	846	0.16	135
February	203	582	582	0.11	64
March	319	706	706	0.06	42
April	542	767	775	0.29	225
May	126	331	331	0.09	30
June	528	807	707	0.21	148
July	369	831	804	0.11	88
August	287	767	775	0.10	78
September	353	538	474	0.22	104
Total	3611	8364	7981	0.17	1351

Table 3. Cast Net Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	244	240	329	0.46	151
November	238	671	370	0.15	56
December	343	852	598	0.04	24
January	373	465	297	0.41	122
February	309	475	36	0.87	31
March	483	1370	1017	0.44	448
April	798	1063	587	0.37	217
May	218	372	104	0.08	8
June	185	441	334	0.29	97
July	787	1255	632	0.19	120
August	240	603	405	0.08	32
September	276	701	474	0.07	33
Total	4494	8708	5183	0.26	1339

Table 4. Gill Net Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	335	666	507	0.39	198
November	363	1205	363	3.60	1307
December	342	1185	272	3.60	979
January	453	1348	446	0.35	156
February	171	663	223	0.17	38
March	291	796	1017	0.23	234
April	300	637	146	0.38	56
May	399	539	132	0.42	55
June	442	465	216	0.34	73
July	269	632	182	0.51	93
August	184	439	203	0.51	104
September	209	2578	678	1.41	956
Total	3758	11153	4385	0.97	4249

Table 5. Surround Net Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	728	2160	362	7.20	2606
November	763	3358	1127	2.18	2457
December	738	3198	973	2.20	2141
January	560	2567	433	4.90	2122
February	400	2092	270	15.63	4220
March	540	2509	402	8.98	3610
April	311	1480	271	2.53	686
May	210	1294	377	3.16	1191
June	517	1621	261	2.57	671
July	106	797	156	3.74	583
August	182	773	125	4.48	560
September	405	1387	210	5.08	1067
Total	5460	23236	4967	4.41	21914

Table 6. Spearfishing with Snorkel Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	248	545	581	0.92	535
November	246	569	467	1.52	710
December	156	319	246	1.13	278
January	257	523	347	0.54	187
February	178	573	526	0.22	116
March	263	1426	1353	0.22	298
April	597	655	612	0.01	6
May	196	295	295	0.08	24
June	467	3594	3567	0.11	392
July	150	247	123	2.34	287
August	118	261	211	1.03	217
September	246	573	172	0.42	72
Total	3122	9580	8500	0.37	3122

Table 7. Expanded Spearfishing with SCUBA Census Data, for fiscal year 1983. Kg/G-H = Kilograms per gear-hour. See text for explantion.

Year	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
Oct. 1, 1982 - Sep. 30, 1983	837	1257	1257	1.3	1634

Table 8. Octopus Fishing Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	93	140	225	1.40	315
November	71	358	308	0.59	182
December	52	115	108	0.56	60
January	41	189	60	0.35	21
February	241	388	281	0.21	59
March	104	164	120	0.21	25
April	138	672	594	0.17	101
May	196	295	295	0.15	44
June	91	249	255	0.16	41
July	94	246	254	0.28	71
August	81	140	155	0.57	88
September	141	219	308	0.42	129
Total	1343	3175	2963	1.18	1136

Table 9. "Other" Fishing Methods Census Data, expanded and summarized by month for fiscal year 1983. Kg/G-H = Kilograms per gear-hour.

Month	Number of Persons	Person-Hours	Gear-Hours	Kg/G-H	Catch (Kg)
October	140	148	148	0.68	101
November	136	148	115	1.01	116
December	99	107	50	1.01	51
January	133	157	123	1.01	124
February	141	409	409	1.01	413
March	203	239	185	1.01	187
April	277	300	236	2.02	477
May	165	267	88	5.12	451
June	98	18	14	1.20	17
July	291	246	254	1.61	409
August	116	221	2	1.61	3
September	476	410	113	0.37	42
Total	2275	2670	1737	1.38	2391

Table 10. Summary of Participation, Catch and Effort, by inshore fishing method for fiscal year 1983.

Method	Persons Per Yr. (%)	Person-Hours(%)	Gear-Hours(%)	Catch (Kg)(%)
Hook and Line	3611(14.5)	8364(12.3)	7981(21.6)	1351(3.6)
Cast Net	4494(18.1)	8708(12.8)	5183(14.0)	1339(3.6)
Gill Net	3758(15.1)	11153(16.4)	4385(11.9)	4249(11.4)
Surround Net	5460(21.9)	23236(34.1)	4967(13.4)	21914(59.0)
Spearfishing with Snorkel	3122(12.5)	9580(14.1)	8500(23.0)	3122(8.4)
Spearfishing with Scuba	837(3.4)	1257(1.8)	1257(3.4)	1634(4.4)
Octopus Fishing	1343(5.4)	3175(4.7)	2963(8.0)	1136(3.1)
Other Methods	2275(9.1)	2670(3.9)	1737(4.7)	2391(6.4)
Total	24900	68143	36973	37136

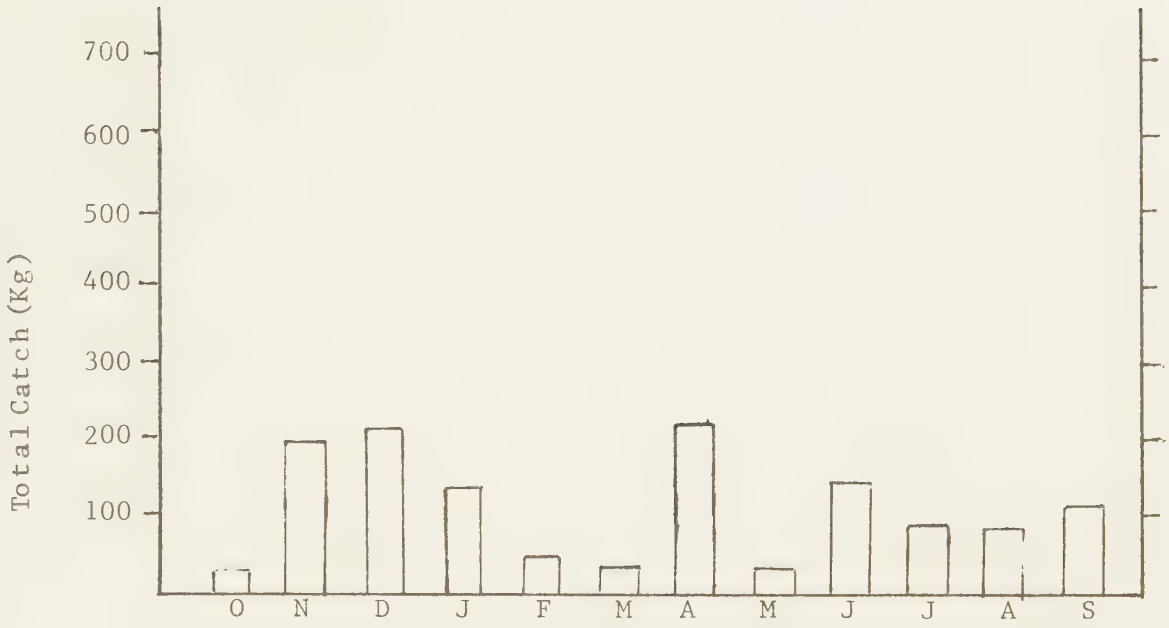


Figure 2. Monthly total catch (Kg) for hook and line fishing.

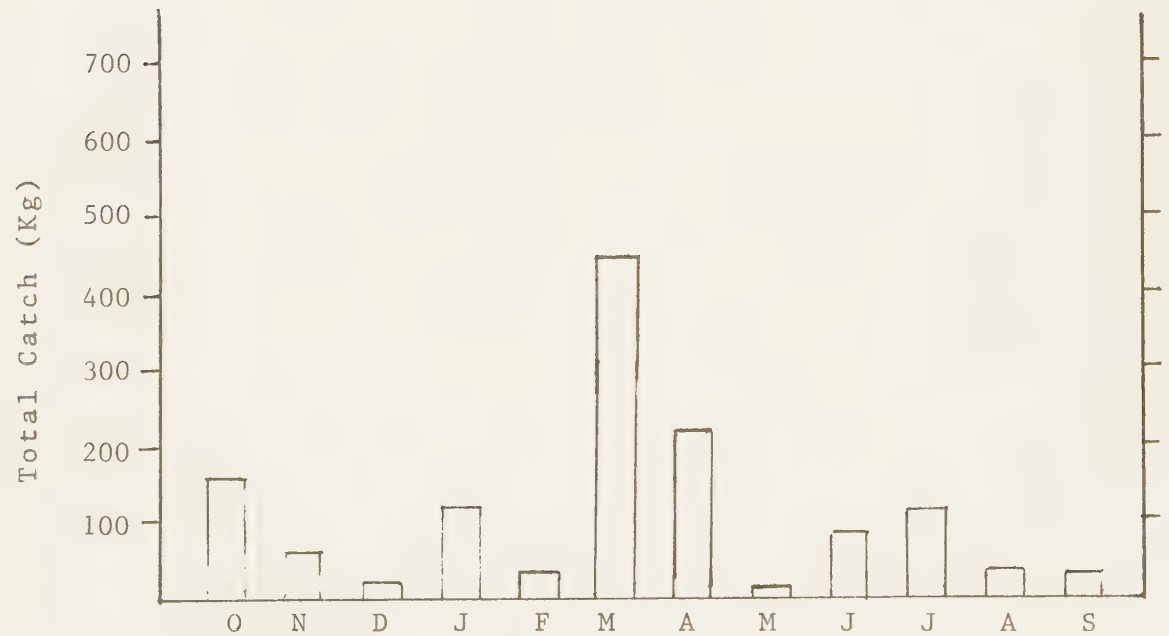


Figure 3. Monthly total catch (Kg) for cast net fishing.

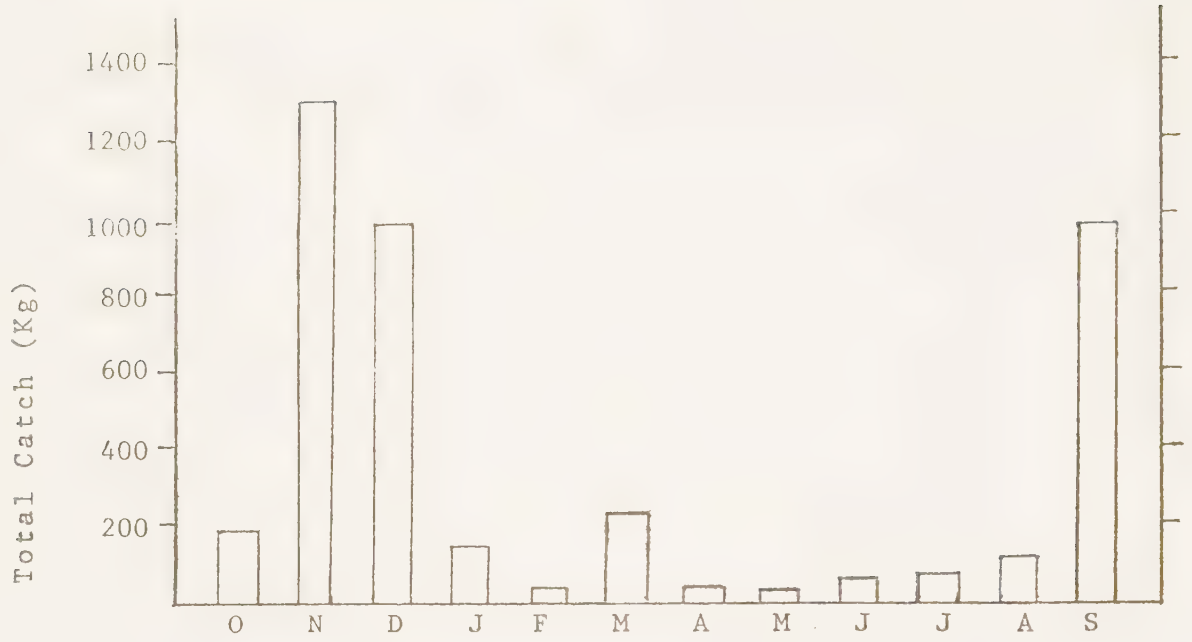


Figure 4. Monthly total catch(Kg) for gill net fishing.

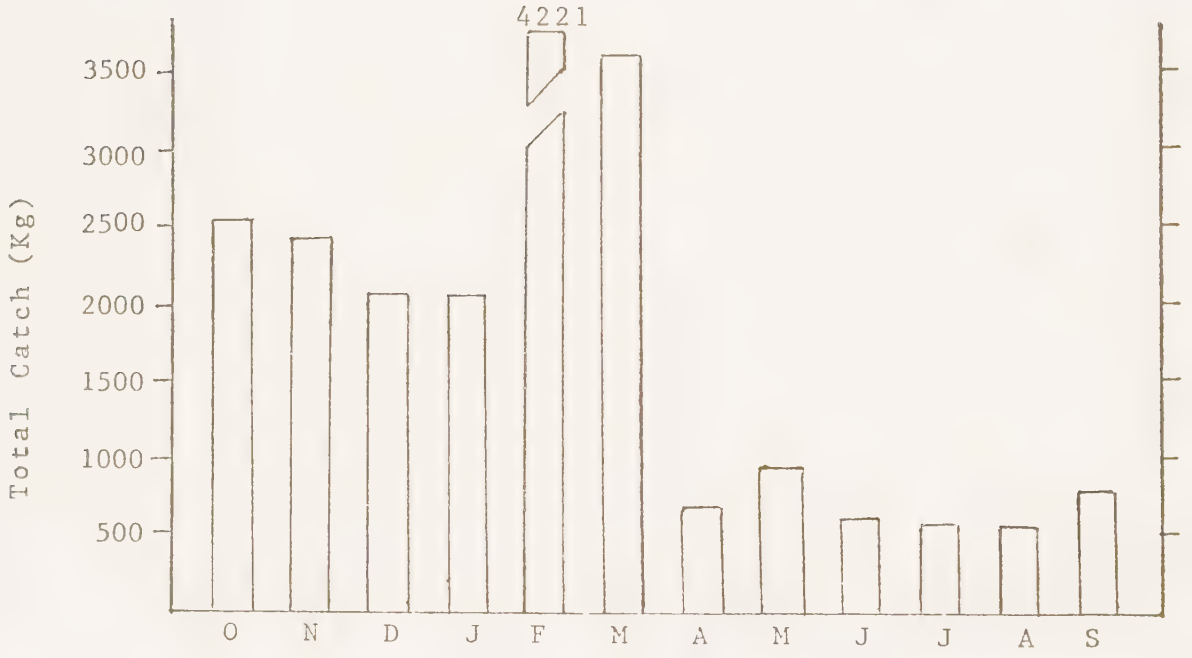


Figure 5. Monthly total catch(Kg) for surround net fishing.

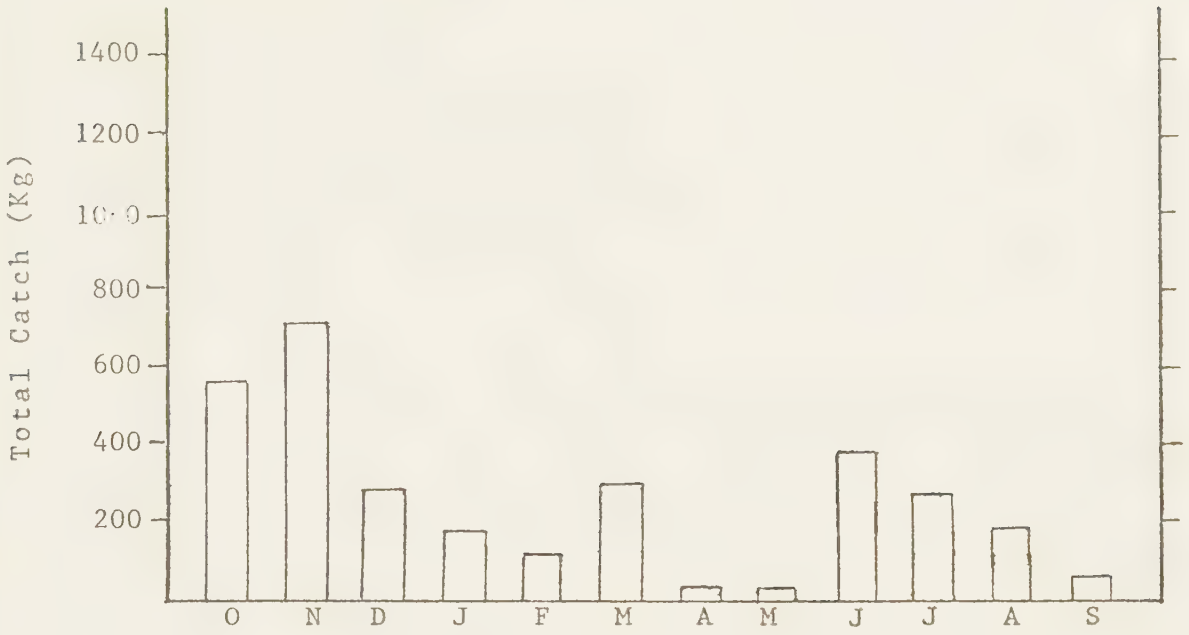


Figure 6. Monthly total catch (Kg) for spearfishing with snorkel gear.

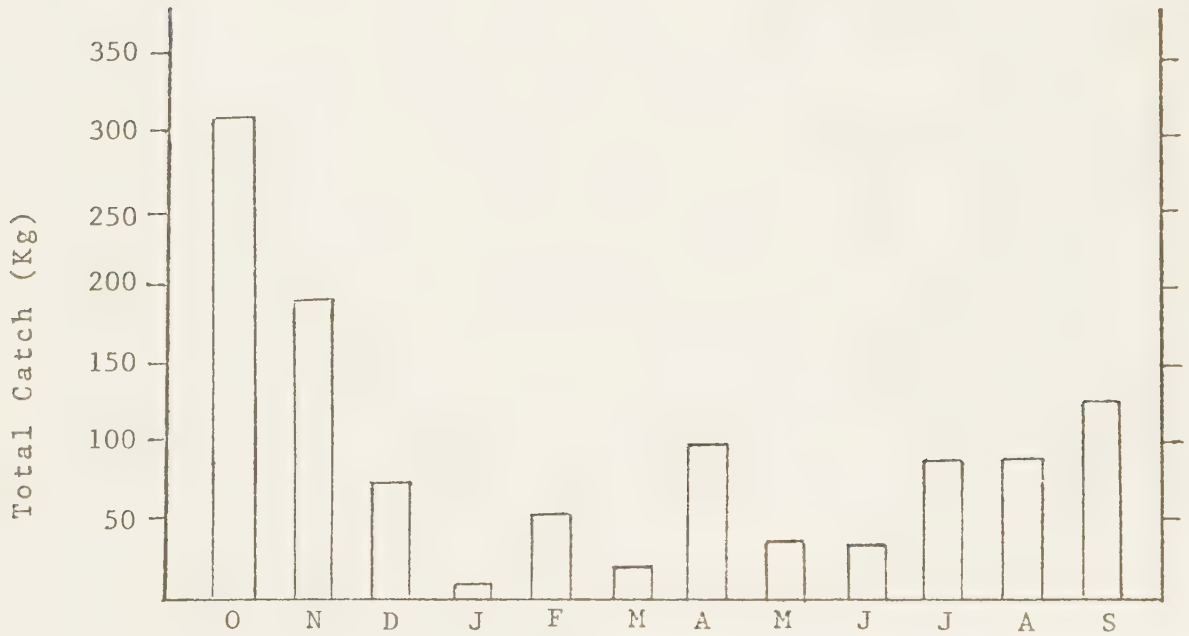


Figure 7. Monthly total catch (Kg) for octopus fishing.

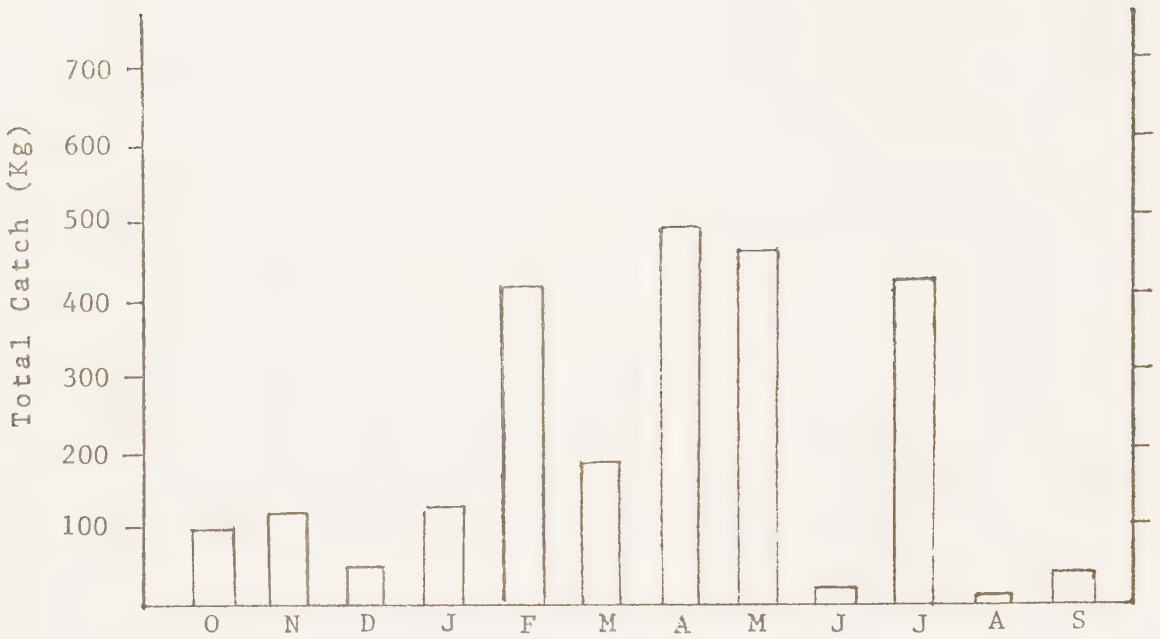


Figure 8. Monthly total catch (Kg) for "other" fishing methods.

While the method of fishing to which the greatest person-hours of effort were directed was surround netting (34.1%), this method was responsible for only 13.4% of the total estimated gear-hours. Gill net fishing, on the other hand, ranked second in person-hours with 16.4%, and accounted for 11.9% of gear-hours; spearfishing with snorkel followed with 14.1% of the person-hours, and ranked first in gear-hours with 22.1% of the total estimated gear-hours. Estimated fishing effort in both person-hours and gear-hours for all methods also appears in Table 10.

In terms of productivity, surround netting was the most productive method having CPUE values which were the highest among all those censused, ie., 0.60 Kg/person-hour and 4.41 Kg/gear-hour. This method alone contributed over 59% of the estimated total catch. Gill netting produced about 11.4% of the total catch with a CPUE value of 0.26 Kg/ gear-hour. Spearfishing with snorkel was responsible for 8.4% of the yearly take with a corresponding catch rate of 0.37 Kg/gear-hour. Catch estimates for all methods are displayed in Table 10.

Readers should be aware that we consider our spearfishing estimates to be very conservative since it remains the most difficult inshore fishing method for us to census. Spearfishers are often invisible and inaccessible to interviewers and the most productive fishing hours are after dark when no creel census interviews are conducted. In fact, during FY 83, we encountered no spearfishers with SCUBA for interview although we know that a substantial amount of such fishing commonly occurs year round. For this reason, the total catch estimated for spearfishing with SCUBA is based on a CPUE value that resulted from averaging CPUE for the same method in our offshore creel census data (See Study F-1, Job 1) with that calculated for inshore spearfishing with snorkel.

In addition to the above fishing methods, several less popular methods were also surveyed during FY 83. One of these was octopus fishing with hook and gaff. An estimated 1343 people hunted for octopi on Guam's reef flats during the year. This method yielded an estimated 1136 Kg of octopi, representing 3.1% of the total estimated annual catch and a CPUE of 1.18 Kg/gear-hour. Furthermore, an estimated 2275 persons used "other" methods to harvest marine life from Guam's reefs. The "other" methods category encompasses any method that was censused secondarily to one of the seven major inshore fishing methods, and includes the hand-harvesting of shelled-mollusks and echinoderms. The majority of these interviews involve persons harvesting shelled-mollusks, primarily the clam, Gafrarium tumidum, and the top shell, Trochus niloticus. These people harvested an estimated 2391 Kg in 2670 person-hours of effort (1.38 Kg/gear-hour). These values are the result of the relatively low effort required to harvest these heavier types of non-fish biomass.

Similar to last year, manahac runs during FY 83 were also light. Sporadic runs occurred in April and March around the last quarter moon. The largest occurred during May in the Merizo area. An estimated 50 Kg of manahac were reported harvested. The total reported manahac harvest for FY'83 was less than 100 kg as compared to the FY 82 harvest that was estimated at 500 Kg. Althoughh the factors affecting these runs are not clear, a possible cause of low-yield years is that the stocks are being overharvested. Since the seasonal harvest of juvenile rabbitfish

(Siganidae) is anticipated by local fishers, participation is normally very high. During the runs, juveniles come over the reef in large, concentrated masses, allowing fishers to net a large percentage of the individuals recruiting to a given area. This form of highly intense fishing effort in conjunction with the harvesting by net of large numbers of adults during their spawning periods may result in the serious reduction of a whole year's recruitment stock. This problem is being examined within the scope of Study F-1, Job 8.

Due to its relative isolation, complexity and large area the Merizo/Cocos Lagoon region is a very difficult one to sample adequately from shore. The vast majority of the fishing activities that occur in the lagoon and on the barrier reefs, and associated islands, are currently not sampled at all. In DAWR's annual report on Inshore Creel Census for FY 82, average annual estimates of fish harvested from the lagoon during the day and by spearing at night were given. If these estimates, along with the recorded FY 83 fish-weir catch, are added to the estimated total inshore catch for FY 83, the following breakdown results:

37,136 Kg -	estimated FY 83 inshore catch (from creel census)
6,856 Kg -	reported FY 83 fish weir catch
100 Kg -	censused FY 83 manahac catch
4,532 Kg -	average estimated annual daytime inshore catch (Cocos Lagoon)
3,504 Kg -	average estimated annual nighttime spearing catch (Cocos Lagoon)
52,128 Kg	Estimated total FY 83 inshore harvest

Since these figures do not account for fish harvested at night other than by spearing in Cocos Lagoon, in uncensused areas, or illegally through the use of explosives or poisons, and probably underestimate the number of fishable days that occurred in FY 83, readers should regard them as minimum estimates.

RECOMMENDATIONS

The collection of more accurate participation data and the refinement of our standard expansion formulae have allowed us to produce better estimates of inshore participation, effort and catch. Further improvements will include adjusting our participation surveys to 20% for both weekdays and holidays. Therefore, beginning in FY 84 we will sample participation on six weekdays and two holidays per month. Effort and catch will be sampled on four days per month in order to increase the scope of data collection. As time permits we also intend to examine the possibilities which exist for collecting more accurate data on spearfishing and other night fishing activities. As the WPACFIN program (See Study F-1, Job 3) progresses we expect that the expansion formulae used on the inshore fishing data will be replaced by an algorithm program similar to that now used on the offshore fishing data.

Report prepared by: Gerald W. Davis

PROJECT TITLE: Fish Weir Report

PERIOD COVERED: October 1, 1982 to September 30, 1983

A total catch of 6,856.5 kg of fish was reported in monthly catch reports submitted by the six fish weir operators licensed in FY 83. Reports were completed for all months and all sites during which weirs were operational, eliminating the need for expansion of the data.

Average daily catch rates for a given month fluctuated widely at each site, ranging from 1.13 kg/day to 21.87 kg/day (Table 1). The mean daily catch rate for FY 83 ranged from a low of 2.06 kg/day at Site 4* to a high of 10.00 kg/day at Site 3. The average mean daily catch rate for all six sites was 5.74 kg/day, while the mean daily catch rate for all six sites combined (taking into account differences in operating time at each site) was 5.98 kg/day. The six sites were operated an average of 198.5 days each, or 54.4% of the time during FY 83. Site 3 was operational the least number of days (98) while Site 1 was operational the greatest number of days (328).

Theft was reported on a per day basis for Sites 4,5 and 6. Taking this into consideration, these sites were legally harvested over a combined total of 474 operational days while thieves made off with the harvest of 43 operational days (all but two days at Site 5) or 8.3% of the total number of operational days. Although theft was also reported for Sites 1,2 and 3, quantification of the number of operational days lost to theft at these sites was not possible. Assuming the theft rate at these sites was comparable to that of Sites 4,5 and 6, we estimate that 99 operational days were lost to theft. Based on a catch rate of 6.29 kg per day for the 1092 operational days in which the catch was not stolen, we estimate that thieves made off with 622.4 kg of fish. By combining the legal and illegal harvests we estimate that 7,487.9 kg of fish were harvested by the six weirs during FY 83. Because of sporadic reporting of theft in the past, it has not been possible to estimate theft rates for previous years.

The FY 83 total reported harvest of 6,865.5 kg, represents an increase of 54.6% from that of FY 82, but is still 18.4% lower than the total estimated harvest of 8,413 kg for FY 80. Part of the overall increase in the FY 83 harvest over that of FY 82 is due to a 26.0% increase in the number of operational weir days. This may be attributable to the relatively storm-free weather experienced during FY 83. In addition, the overall FY 83 catch rate increased by 22.6% over that of FY 83.**

Report prepared by: Robert F. Myers

*Excluding days of reported theft from the number of operational days used in the calculation of catch rate.

**Based on calculations that do not take theft into consideration.

Table 1. Average daily catch rates (kg/day in operation) for the licensed fish weirs operating in the Merizo/Cocos Lagoon region during FY-83.*

Site #	Location	Month Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY-83	No. of days in Operation
1	Tamogi-Afgo	-	5.39	4.36	5.50	7.24	3.54	9.15	5.44	3.52	4.86	4.54	4.71	5.28	328 (301+)
2	Hasta-Sagua Dano	-	-	1.13	21.87	12.91	17.46	6.62	10.83	4.45	4.21	5.51	8.39	8.39	248 (227+)
3	Aaguan-Acho Dekiki	-	-	-	-	-	14.61	14.11	1.78	8.08	-	-	-	10.00	98 (90+)
4	Sagua Usao-Ton Vicente	-	-	-	-	-	2.87	2.30 (2.38)	2.22	1.44	2.31	2.41	1.22	2.05 (2.06)	175 (174)
5	Aba-Aang	-	-	6.29 (10.07)	3.42 (3.66)	7.07 (8.84)	3.47 (6.32)	5.06 (5.84)	2.97 (3.17)	3.04 (3.51)	3.47 (3.71)	3.15 (3.75)	2.85 (6.65)	3.66 (4.43)	235 (194)
6	Sagua Usao-Mapua	-	-	-	-	-	-	-	-	9.51	8.02	8.95 (9.36)	7.71	7.99 (8.07)	107 (106)
	All Sites**	-	5.39	3.93 (5.19)	10.26 (10.34)	9.07 (9.66)	8.39 (8.96)	6.21 (6.35)	4.65 (4.69)	5.01 (5.09)	4.57 (4.62)	4.91 (5.11)	4.98 (5.74)	6.23 (6.37)	1191 (1092)

* Figures in parentheses are based only on days in which the catch was not reported as stolen.

\+ Estimated based on the average theft rate of Sites 4,5 and 6.

** Means for all sites combined are based on an average of each site's monthly mean.

The mean daily catch rate for all six sites combined, taking into account differences in operating time among sites, was 5.76 kg/day (6.29 kg/day).

Table 2. Composition of fish weir harvest reported for FY'83.

Fish Family	Reported Catch (Kg)	Percent (%) of Total Catch
Acanthuridae (Surgeonfishes, Kicho)	97.5	1.4
Carangidae* (Jacks, Tarakito)	866.2	12.6
Carangidae *S. crumenopthalmus* (Atulai)	79.8	1.2
Leiognathidae (Soapys, Guaguas)	349.9	5.1
Lethrinidae/Lutjanidae (Emperors, Mafute)	1,038.6	15.1
Mugilidae (Mullets, Laiguan)	521.5	7.6
Mullidae (Goatfishes, Salmoneti)	2,750.5	40.1
Serranidae (Groupers, Gadao)	46.7	0.7
Siganidae (Rabbitfishes, Sesyun)	167.0	2.4
Others	947.8	13.8
Total (12 mo.)	6,865.5	100.0

*Excluding *Selar crumenopthalmus*

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 3

JOB TITLE: Data Processing for Creel Census

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

During FY 83 a usable input format for the storage of offshore creel census data was developed similar to that used for the inshore creel census data. In addition, considerable time was spent modifying and refining both formats. Data input also continued, reaching a current level of 11,265 inshore records covering a period from January 1980 to February 1983. Preliminary report formats for the analysis of inshore data were developed and generated while the offshore creel census interview forms for FY 83 were coded. A draft report entitled "A Fishery Data Collection System: Guam" by Mr. E. Brazier of CIC Research, Inc. was reviewed during the year, and the final report was received in September 1983.

BACKGROUND

Marine fishing activities on Guam have been surveyed by the Division of Aquatic & Wildlife Resources (DAWR) since mid-1960 in order to identify trends in fishing participation, effort and catch among various fishing methods employed and, ultimately, to help assess the state of the exploited fish stocks. Over the years Guam's marine fisheries resources have come under considerable pressure from recreational, subsistence and commercial interests, and the need to assess and manage these resources has also become great.

On a broader scale, the need to develop a strong marine fisheries data base within the U.S. has become increasingly important since the passage of the Magnuson Fishery Conservation and Management Act of 1976. This act established eight Regional Fishery Management Councils whose primary mission is to prepare fishery management plans upon which management regulations within the U.S. Fishery Conservation Zone may be promulgated. To provide the Western Pacific Fishery Management Council with coordinated access to quality fisheries data needed for management purposes, the Western Pacific Fisheries Information Network (WPACFIN) was created in 1980. Guam has participated in the WPACFIN since its beginning through the membership of the DAWR.

In response to the need for adequate marine fisheries management on both local and national levels, the DAWR creel census effort has increased dramatically since 1977. In order to more efficiently handle our expanding fisheries data base, computerization has become a viable and necessary avenue for documentation and quality control. In FY 79 steps were taken toward the initiation of Job 3, Data Processing for Creel Census, however, this job remained inactive until FY 82 when the requirements for the WPACFIN program were established. Since that time the DAWR has continued to pursue its management objectives through funding from the National Marine Fisheries Service (NMFS), the Western Pacific Regional Fisheries Management Council, as well as the U.S. Fish and Wildlife Service (USFWS).

OBJECTIVES

The general objectives and goals of Job 3 include but are not limited to the following:

1. Computerize high-quality historical and current marine creel census data.

2. Transfer finalized computer files to the NMFS, DEC 11/70 computer in Honolulu for region-wide WPACFIN application and exchange.

3. Increase the efficiency and statistical reliability of marine fisheries data collection and analysis.

4. Obtain reliable estimates of total island-wide harvest from the inshore and offshore marine fisheries.

5. Obtain estimates of fish harvest and productivity for specific reef areas and habitat categories.

6. Assess individual inshore and offshore fishing methods for effectiveness and selectivity.

7. Obtain population and life history information for important harvested fish species.

RESULTS

In February, 1982, Mr. D. Hamm (NMFS) completed the installation of DAWR's microcomputer system and conducted training sessions. The components of this system have been upgraded through FY 83 and now include an Apple II computer with a 68K RAM capacity, an additional 68K RAM accelerator card, a video display unit, two disk drive units, a microfazer, a printer and associated software.

After the installation of our microcomputer system, the primary effort of DAWR data processing personnel was 1) to compose a complete and useful format for data input and 2) to proceed with this input and devise analytical capabilities for system use. Step 1 has essentially been achieved but, because of personnel changes, step 2 has proceeded at a slower pace.

In December 1982, Mr. E. Brazier (WPACFIN-funded statistical consultant) spent a week on Guam studying the current creel census program with DAWR biologists. A draft of his report entitled "A Fishery Data Collection System: Guam" was reviewed by our staff for historical accuracy. The final report (NMFS Administrative Report H-83-21C) was received in September 1983. Based on the recommendations in that report our creel census procedures have been refined to increase efficiency in the field as well as improve statistical reliability of derived monthly and annual catch estimates.

During FY 83, efforts were directed primarily at refining internal record formats for inshore and offshore creel census data. At the present time the inshore creel census is divided into a participation census and a catch census (see Job 2, Inshore Creel Census), with data from each census being input into different but compatable formats. A participation census gives less information than does a catch census, but is extremely valuable as an expansion tool when determining the estimated catch for each fishing method. A usable offshore census format was developed and it is somewhat similar to the inshore catch census format. Offshore census forms for FY 83 have been coded and are currently being entered onto computer files. As time permits past offshore data will be coded and entered in a manner similar to that of the historical inshore data.

Internal census formats are easily modified to accommodate pertinent data. In the past, an obvious difference has been noted in the fishing participation data between weekends/holidays (WE/H) and weekdays (WD). Therefore, during FY 83 a new field was added to the census formats and edited into the previous year's data. Also, climatological factors were incorporated into the format with hopes of integrating this information into the final analysis later on.

Data input continued during FY 83. Presently, there are 11,265 inshore records on file covering a period from January 1980 to February 1983. Because of changes in data processing personnel, training is in progress and data entry is currently at a minimum. However, an attempt will be made to update FY 83 files by December, 1983. A data management software program (DB Master) is being used for the actual entry of data. Preliminary participation, effort and catch reports, segregating data by fishing method, month, locations and tidal period have been generated and used for analyses.

DAWR creel census data are analyzed and reported on a fiscal year (October-September) timetable. Because the computer files were originally stored in calendar year (January-December) sequence, searching and editing the data base was found to be somewhat time consuming. Conversion from calendar year to quarterly storage will be implemented once data input is updated. This will provide more flexibility and greater efficiency in data retrieval, report generation and analyses.

RECOMMENDATION

Although flawed in certain respects, past DAWR Creel Census efforts have yielded a good deal of reliable information, especially since 1977. However, because of deficiencies in past survey designs the accuracy of past estimates could not be measured within specific confidence limits. From a management perspective, it is desirable to obtain the most accurate estimates possible for specific fisheries, locations and for the whole island. Because of the recent reactivation of Job 3, only the mechanical aspects of file formation and maintenance have been developed. To maximize the computers potential, every effort should be made to increase data input and to properly train personnel so that file statistics, data analysis, and report generation can be effectively integrated to allow for a more efficient creel census effort. The WPACFIN program should enable DAWR to fine-tune its filed creel census procedures and to more accurately estimate the island's total fishing participation, effort and catch.

Report prepared by: Robert D. Rinehart and Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROGRESS SEGMENT

STATE: Territory of Guam

PROJECT NO. FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 8

JOB TITLE: Studies of Recreationally Important Reef Fish

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Beginning in January of 1982, populations of recreationally important reef fish species were monitored monthly at three sites on Luminao Barrier Reef in order to evaluate the effectiveness of closure of the reef to net fishing on October 1, 1981 and to all forms of fishing on October 1, 1982. At all three sites large individuals (>25 cm FL) were greatly outnumbered by smaller-sized individuals. The abundances of each size class within fish populations were highly variable at all three sites and no trends were apparent. Because of the unwillingness of many fishers to cooperate with the closure, and as a result of inadequate security, poaching was a common occurrence throughout the study. It is likely that these reasons combined with the short duration of closure prevented the development of observable trends.

The second portion of Job 8, involving studies of the biology of selected species of recreationally important reef fishes, was inactive during FY 83, but will be resumed as soon as a vacant fisheries biologist position is filled.

BACKGROUND

In addition to reliable data on fishing participation, effort and catch, proper management of a fishery requires pertinent biological knowledge of the species involved. Such information may be used as a basis for sound management decisions in maintaining or improving the quality of sport fishing on Guam while providing requisite data to support government policy and laws related to fish and fishing.

On October 24, 1981, Public Law 16-39 went into effect, closing the Luminao Barrier Reef along the north (ocean) side of Apra Harbor's Glass Breakwater to all forms of net fishing. At that time the Division of Aquatic and Wildlife Resources (DAWR) assumed the responsibility of monitoring populations of recreationally important reef fishes. On December 3, 1982, Public Law 16-114 went into effect, closing the Luminao Barrier Reef to all fishing or taking of any marine life, by any means, for a trial period that ended on October 1, 1983. At that time, Luminao Barrier Reef was reopened to all forms of fishing.

During the latter part of 1980, a study of the fish communities of the Luminao-Piti reef complex was conducted (Myers, 1982). The sampling method (primarily the use of 50m transects) was designed to roughly enumerate the populations of all resident reef fish species. This study did not concentrate specifically on the more recreationally important species, such as the larger resident and transient species and seasonal juveniles. Many of these occurred in low numbers, or seasonally, and may have been overlooked. For these reasons, and in response to the closure of Luminao Barrier Reef to the taking of marine life, an independent study utilizing a different methodology was initiated by DAWR in January 1982 and terminated at the end of September 1983.

The second part of Job 8 involves obtaining more specific information on the biology and life history of selected reef fish species. Among the more recreationally important inshore species traditionally targeted by fishers on Guam are Siganus spinus (Signaidae), Mulloides flavolineatus (Mullidae), Caranx melampygus and Selar crumenopthalmus (Carangidae). Culturally, these species are highly desired both as juveniles and adults, so their stocks must sustain considerable levels of fishing pressure. As the island of Guam develops, and as fishing continues to be an increasingly important recreational activity for residents and tourists alike, these and other species must be conserved and protected from overexploitation and misuse.

OBJECTIVES

1. To monitor population trends of recreationally important reef fishes on Luminao Barrier Reef, shoreward of the reef margin.

2. To assess the impact of fishing on populations of recreationally important reef fishes on Luminao Barrier Reef.

3. (Inactive during FY 83) To obtain sufficient information on the biology and life history of selected recreationally important reef fish species (such as Siganus spinus, Selar crumenophthalmus, Caranx melampygus and Mulloides flavolineatus) in order to permit an adequate assessment of the need for fishing regulations and population management.

PROCEDURES

Three sites, each representing somewhat different major habitats, were selected (Figure 1). The first is situated on the eastern end of the reef, approximately 10 meters from the Glass Breakwater and opposite the "ammunition wharf". The remaining two are situated near the western end, and widest point, of the reef. One is located within 20 m of the Glass Breakwater, the other in an area of rich coral growth within 70 m of the reef margin. At each site, two stakes were driven into the substrate to designate endpoints of permanent 100 m transects running parallel to the Glass Breakwater. Beginning in January, 1982, a series of monthly counts were conducted along each transect. All fishes that were considered recreationally important, and observed with 3 m of an imaginary transect line, were tallied. Nocturnal species which often occur in holes and under ledges by day were not considered, nor were a few species incidentally utilized by fishermen. All species were separated into approximate size

intervals of 7-12.5 cm, 12.5-25 cm, and 25 cm Fl, respectively. Newly recruited juveniles of certain species were also tallied. All monthly counts were taken within a 1 to 2 day period. In an effort to minimize variability due to temporal and tidal factors, all counts were conducted between the hours of 1300 and 1700, and during tidal levels of approximately 1.5 ft. above mean low water.

Procedures pertinent to the second portion of Job 8 (inactive during FY 83) are outlined in the DAWR FY 82 annual report. Although some work was conducted during FY 82 the results of this portion will be presented in our next annual report after additional data are collected and analyzed in a more comprehensive fashion.

RESULTS

The most obvious general characteristic of the fish counts made at Luminao Barrier Reef was their variability. This holds true for counts of all size classes (except seasonal recruits) and sites, making it difficult to detect and interpret trends. A number of factors may have contributed to this variability, and these include: (1) the transient nature of many species within the transect area, (2) variability between counts in the area surveyed, due to difficulty at some sites, in swimming a straight line, (3) omissions and duplications in counts due to the rapid and simultaneous movement of many different individuals and species, and (4) inaccuracy in visually separating size classes within and between species. It is widely known that sampling by means of visual counts along transects provides only crude estimates of the relative abundances of fish populations. It is, however, the best nondestructive method available, and the only practical one in the present situation. Despite its flaws, this method should eventually allow detection of long-term trends.

It should be noted that this study concerns only the potentially exploitable, diurnally active, food-fishes represented in Figure 2. These include parrotfishes, most species of surgeonfishes, a few of the larger wrasses, snappers, emperors, groupers, scorpionfishes, rabbitfishes and sharks (Table 1). Juvenile (Ee) and adult (Tarakityo and Tarakito) Bluefin Trevally (Carangidae: Caranx melampygus) were not encountered on the transects, but were observed in the area. At all three sites, large fishes (>25 cm Fl) were greatly outnumbered by smaller size-class fishes, of both the same, and different species. Approximately equal numbers of small and medium size-class individuals were surveyed throughout most of the study period, although these numbers fluctuated widely.

There were consistent differences in the numbers and relative proportions of small, medium and large size-class individuals among the three sites. This was probably due to differences in average depth, reef zonation and bottom physiography among the sites. Site 1 was the shallowest, the closest to the shoreline and had a high proportion of dead Acropora which afforded ideal shelter and feeding grounds for juvenile scarids and acanthurids. Not surprisingly, Site 1 had the highest mean density of small and medium size-class individuals (13.9 and 12.0 individuals per 100 m^2, respectively). In contrast, Site 1 had the lowest mean density of large size-class individuals (0.3 individuals per 100 m^2). This was probably due to the lack of suitable shelter since there were few sizable coral heads and

the adjacent shoreline consisted of a sandy beach. Site 2 was the deepest, was close to the rocky subtidal portion of the breakwater, and had a substratum consisting primarily of sand and rubble. It had the lowest mean density of small and medium size-class individuals (7.0 and 6.3 individuals per 100 m^2, respectively) but many more large size-class individuals (1.3 individuals per 100 m^2) than did Site 1. Site 3 was moderately shallow, farthest from shore and had the highest proportion of live coral which provided shelter ideal for individuals of all three size classes. It had the highest mean density of large size-class individuals (1.7 individuals per 100 m^2) and nearly as high a mean density of small and medium size-class individuals as did Site 1 (11.3 and 10.9 individuals per 100 m^2, respectively).

Although there were numerous consistent differences in the relative densities of different size-class individuals among sites, there were no apparent trends within sites. There are probably two major reasons for this; one is that enforcement of the closure law was generally inadequate. Fishing by numerous methods was observed throughout the study period. It seemed well-known among poachers that there was little risk of successful prosecution and much of the time there was an undercurrent of public opposition to the closure.

Even with limited success the closure was of too short a duration for any trends to become well-established. One year's closure time (for all fishing methods) is too short for most nonseasonal exploited species to grow significantly or become well-established.

RECOMMENDATIONS

This study was terminated when the closure law expired after September 30, 1983. It is recommended that transect studies of recreationally important fish populations on Luminao Barrier Reef be resumed after a well-planned, long-term closure takes effect, or when studies of the life history or biology of selected species of reef fishes is continued.

REFERENCES

Myers, R.F. 1982. Fishes. In: R.H. Randall and L.G. Eldredge (eds.), Assessment of the shoalwater environments in the vicinity of the proposed OTEC development at Cabras Island, Guam. Univ. of Guam Marine Lab., Tech. Rept. No. 79:132-173.

Report prepared by: Robert F. Myers and Michael E. Molina

Table 1. List of Recreationally Important Fish Species Monitored on Luminao Barrier Reef.*

Species

Carcharhinidae (Sharks)
+Carcharhinus melanopterus
Muraenidae (Moray Eels)
Echidna nebulosa
Scorpaenidae (Scorpionfishes)
+Scorpaenopsis diabolus
Serranidae (Groupers)
Epinephelus merra
E. tauvina
Lutjanidae (Emperors)
Lutjanus fulvus
Nemipteridae (Monocle Breams)
Scolopsis cancellatus
Gerreiidae (Mojarras)
Gerres sp.
Lethrinidae (Emperors)
Gnathodentex aureolineatus
Lethrinus harak
L. xanthochilus
+Monotaxis grandoculus
Mullidae (Goatfishes)
Mulloides flavolineatus
M. vanicolensis
Parupeneus atrochingulatus
P. barberinus
P. bifasciatus
P. cyclostomus
P. pleurostigma
Pomacentridae (Damselfishes)
Abudefduf septemfasciatus
Labridae (Wrasses)
Anampses caeruleopunctatus[1]
Cheilinus chlorurus
C. trilobatus
Cheilio inermis[1]
Coris aygula[1]
C. gaimardi[1]
Epibulus insidiator[1]
Halichoeres hortulanus[1]
H. marginatus
Hemigymnus fasciatus
H. melapterus
Macropharyngodon meleagris[1]
Novaculichthys taeniourus
Thalassoma hardwickei
T. purpureum
Scaridae (Parrotfishes)
Calotomus carolinus
Scarus brevifilis
S. frontailis
S. globiceps
+S. oviceps
S. psittacus
+S. schlegeli
S. sordidus
+S. rubroviolaceus
Acanthuridae (Surgeonfishes)
Acanthurus glaucopareius
A. lineatus
A. mata
+A. nigricaudus
A. nigrofuscus
A. nigroris
A. triostegus
Ctenochaetus striatus
+Naso annulatus
N. lituratus
N. unicornis
N. vlamingi
Zebrasoma veliferum
Siganidae (Rabbitfishes)
Siganus spinus
Monocanthidae (Filefishes)
Cantherhines dumerili
Balistidae (Triggerfishes)
Balistoides viridescens
Rhinecanthus aculeatus
R. rectangulus

*Only those individuals over 7 cm Fl are considered. Species not listed that may reach 12.5 mm Fl were not considered. Holocentrids were not monitored due to their propensity to stay hidden during daylight hours. Elongate species (Belonidae, Hemiramphidae, Aulostomidae, Fistulariidae) were not considered.

[1]Only medium or large size-class individuals of these species were considered.

+Not listed in Myers (1982).

Figure 1. Map of the Luminao-Piti reef system showing locations of fish transects.

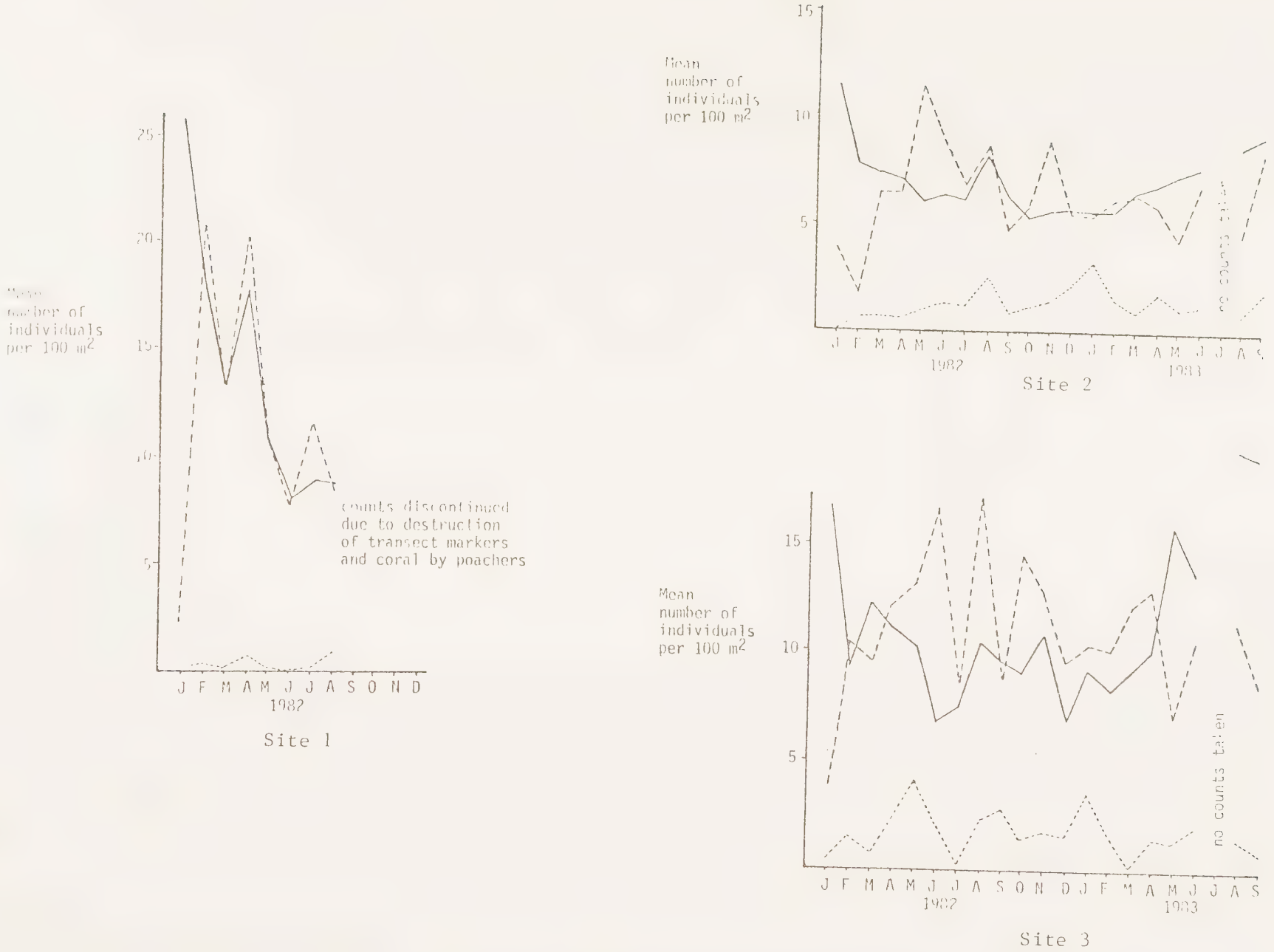


Figure 2. Monthly density fluctuations of different size classes of recreationally valuable fishes on Luminao Barrier Reef during the periods of closure to net fishing and all fishing (see text for explanation). ——— = small (7-12.5 cm Fl); --- = medium (12.5-25 cm Fl); ····· = large (>25 cm Fl).

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 9

JOB TITLE: Pelagic Fish Feeding Study

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

During FY 83, a total of 310 stomachs from 7 species of pelagic gamefishes were examined and their contents recorded. Forty-six of these stomachs were obtained during FY 83, while the remainder were obtained between December 10, 1981 and September 30, 1982. Personnel limitations and altered priorities during FY 83 prevented the examination of all of the stomach samples. The remaining samples will be examined during FY 84.

Since the beginning of this study a grand total of 1,447 stomachs from 7 species of pelagic gamefishes have been collected at either Guam or Rota. One hundred twenty-eight of these were obtained at the Marianas Fishing Derbies and Rota Fishing Derbies during 1982 and 1983. The remainder were obtained at the Guam Fishermen's Cooperative. To date, 925 stomachs have been examined and their contents recorded or preserved for subsequent identification. A preliminary analysis of the data was reported in the Division of Aquatic and Wildlife Resources (DAWR) FY 82 Annual Report. The results of that analysis showed that within the stomachs of the five species for which 10 or more samples were examined, "fish remains" occurred more frequently than any other type of prey item. Mahimahi (Coryphaena hippurus) appeared to feed most frequently on flying fishes, while other species were found to feed heavily on larval or post larval inshore fishes. Crustaceans and cephalopods were more frequently recorded in yellowfin tuna (Thunnus albacares) stomachs than in samples from any of the other species.

BACKGROUND

Numerous studies have indicated that tunas (Scombridae), mahimahi (Coryphaenidae) and billfishes (Istiophoridae) are opportunistic feeders that consume a wide variety of pelagic organisms. When in coastal waters, a substantial portion of their diet may consist of juvenile or larval stages of inshore fishes. Stomachs of blue marlin, yellowfin tuna, and wahoo collected on Guam during recent Marianas Fishing Derbies were found to contain primarily fishes, most of which were larvae or young of reef-dwelling species. Some of these juvenile fishes were similar or identical to those species observed around Guam's Fish Aggregating Devices (FAD). Very little is known about the ecological relationships between reef

fish populations and the pelagic migratory species that support the bulk of Guam's recreational trolling fishery.

OBJECTIVES

1. To broaden the life history information base on Guam's reef fish species, which may be used in assessing the status of reef fish populations for proper management purposes.

2. To determine the feeding habits of Guam's recreationally important pelagic, predator fish associated with FAD's, and identify any feeding changes that may possibly have been incurred by this association.

3. To assess the importance of Guam's reef fish in providing forage for recreationally important pelagic fish.

PROCEDURES

Collection and Preservation

Most of the stomachs needed for this study were purchased under contract from the Guam Fishermen's Cooperative. For each sample, the stomach and, if possible, the gonads were removed and placed into a sealed plastic bag containing an identification number, then frozen for later examination. The species name, fork length, weight, area caught (if known), date caught, and date of removal were recorded. An effort was made to remove the stomach the same day the fish was caught but this was not always possible. An attempt was made to collect up to 10 stomachs per species per collecting site each day stomachs were taken. This, however, was seldom possible. An attempt was also made to obtain 20 or more samples of each species for each month of the year, but this too was rarely possible due to seasonal differences in their availability.

Examination of Stomach Contents and Gonads

After thawing, the contents of each stomach were placed in a shallow tray. Dietary items were sorted to the finest recognizable taxonomic unit, counted, then weighed to the nearest 0.1g after excess fluid was removed. The degree of digestion was estimated for each prey species and certain prey species were measured to the nearest millimeter. Selected prey items were preserved in either 10% formalin or 70% ethanol for later identification or for comparison with contents from other stomachs. In conjunction with this job, a large reference collection has been created and continues to be expanded.

Representative specimens of internal parasites found in the stomach samples were sorted, counted and preserved in 10% formalin. Fish gonads were thawed, weighed (when wet), examined and staged. Selected samples were preserved in 10% formalin.

Analysis of Data

All data have been recorded in a manner that will allow a number of quantitative and qualitative analyses to be performed. Frequency of occurrence, relative abundance by number and weight, and temporal trends will be analyzed. Specific statistical procedures, tests and indices used will be based on usefulness of results and ease of analysis by available computer facilities.

RESULTS

During FY 83 an additional 46 stomach samples were collected for food content analysis. This brings the total number of samples collected for this study to 1,447, distributed among seven species of pelagic gamefishes (Table 1). To date, a total of 925 samples have been examined, with approximately one third of these having been checked during the FY 83 report period.

In our last progress report preliminary results on the diets of five of Guam's most recreationally important troll-caught species were given (Table 2). In all five of these species, fishes occurred more frequently than any other type of prey item. Mahimahi (Coryphaena hippurus) and wahoo (Acanthocybium solandri) were found to feed almost entirely upon fishes; the former primarily upon flying fishes. Wahoo, skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares) and blue marlin (Makaira nigricans) appeared to feed heavily upon larval or post larval inshore fishes. Yellowfin tuna fed almost as frequently upon crustaceans (primarily larvae and post-larvae) as they did upon fishes, and more frequently upon cephalopods than did any of the other species. Cephalopods were important in the diets of blue marlin and mahimahi as well. Crustaceans were relatively important in the diets of skipjack tuna as well as yellowfin tuna, but were infrequently found in stomachs of the other species.

The results of the examinations performed during FY 83 as well as those remaining to be made will be included in next year's DAWR Annual Report.

RECOMMENDATIONS

This study should continue through FY 84. The work to be done includes the examination of remaining stomach samples, the compilation of all data recorded during the entire study and the statistical testing of the data. This work should be completed by the end of FY 84 and a final report for Job 9 should be issued at that time.

Report prepared by: Robert F. Myers

Table 1. Status of stomach content analysis by species as of September 30, 1983.

Species	No. of Stomachs Collected No.	% of Total	No. of Stomachs Examined To date No.	% by Spp.
Coryphaena hippurus	430	29.7	303	70.5
Sphyraena barracuda	25	1.7	9	36.0
Acanthocybium solandri	246	17.0	165	46.7
Gymnosarda unicolor	19	1.4	10	52.6
Katswonus pelamis	316	21.8	213	67.4
Thunnus albacares	308	21.3	170	55.2
Makaira nigricans	103	7.1	55	53.4
Total	1,447	100.0	925	64.0

Table 2. Frequency of occurrence of various prey items found in the stomachs of some of the most recreationally important troll-caught species examined during FY 1982.

Species	Number Examined	No. with food in stomach	% of Total with food in stomach	CONTENTS: Fish Remains No. of Stomachs	% of Total	Crustacean Remains No. of Stomachs	% of Total	Cephalopod Remains No. of Stomachs	% of Total	Unit or Other No. of Stomachs	% of Total
Coryphaena hippurus	283	237	83.7	229	80.9	21	7.4	87	30.7	10	3.5
Acanthocybium solandri	100	65	65.0	62	62.0	3	3.0	17	17.0	3	3.0
Katsuwonus pelamis	130	103	79.2	84	64.6	43	33.1	47	36.2	18	13.8
Thunnus albacares	72	71	98.6	65	90.3	63	87.5	46	63.4	14	19.4
Makaira nigricans	14	13	92.9	13	92.9	2	14.3	7	50.0		
TOTAL	599	489	81.6	453	75.6	132	22.0	204	34.1	45	7.5

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 1

JOB TITLE: Limnological Survey of the Major Streams and Rivers

PERIOD COVERED: October 1, 1982 to September 30, 1983

BACKGROUND

An ecological survey of the Agfayan River mouth was conducted by Aquatic & Wildlife Resources (DAWR) from July 1, 1968 to June 30, 1972. Salinity, pH and temperature data, as well as lists of organisms collected or observed in the river mouth were included in the Annual DAWR Progress Reports. This study dealt primarily with the estuarine system.

In a preliminary study to rehabilitate the Masso River Reservoir into a public fishing and recreation area (July 1, 1971 to June 30, 1972), small gobies, eels and shrimp are mentioned as the principal inhabitants of the reservoir and feeder streams.

A limnological survey of the major streams and rivers of Guam was initiated during the period of June 30, 1974 to July 1, 1975. The Geus River, located in the southern tip of the island, and the Lonfit River in the central highlands, were investigated. Six species of fish, three species of shrimp and an aquatic gastropod were observed or collected from the Geus River. Five of the six species of fish, and two of the three species of shrimp present in the Geus River were also collected or observed from the Lonfit River. Two species of aquatic gastropods were taken in the Lonfit River.

The Geus River was found to be unsuitable for stocking gamefish or development as a fishing area. The Lonfit River was judged suitable for a stocking and development program, however, this was deferred because of limited access to the river. The University of Guam Marine Laboratory Technical Report No. 16 (1974) discusses the physical, limnological and biological components of the Geus River drainage basin. Organisms were collected and catalogued from established stations on the Ylig, Geus and Umatac Rivers during FY 77. Preliminary stomach content analyses of three fish species, Microsicydium elegans, Eleotris fusca and Chonophorus guamensis, were performed during the report period. The collection of air and water temperatures and flow readings was initiated during this period. Breeding and reproduction observations were made of one species of fish.

Water temperatures, flow rates and biological data were collected monthly from permanent monitoring stations on the Geus and Umatac Rivers during FY 1978. The Ylig River was monitored at 3 stations during November 1977 and March 1978.

Seven sampling stations were established on the Ugum and Bubulao River system. The names of the organisms present were listed in our Job Progress Report for FY 79. Observations on the spawning of Microsicydium elegans from the Geus River were included.

During FY 80, preliminary air and water temperature data and water samples were collected from two experimental watersheds in southern Guam. Floral and faunal collections were also made. Data from four vegetational transects were collected. Nitrate, nitrite, ortho and total phosphates, pH, conductivities, turbidity and hardness parameters were determined from water samples.

RESULTS

This job was largely inactive during the report period due to personnel limitations. However, the Division of Aquatic and Wildlife Resources (DAWR) was informed by the University of Guam College of Agriculture and Life Sciences (CALS) of an upcoming project of interest. During FY 84, CALS along with the U.S. Soil Conservation Service and the Bureau of Reclamation will be creating a small impoundment in Southern Guam for irrigation purposes. The small reservoir which will be created was offered to DAWR to use as a recreational fishing area or as an aquaculture site. In the next year DAWR will investigate these possibilities as the project progresses.

RECOMMENDATIONS

This job should be continued at a relatively low level to allow intermittent investigations of Guam's limnological systems, and to investigate the feasibility of utilizing the small impoundment mentioned above.

Report prepared by: Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 2

JOB TITLE: Masso River Watershed Studies

PERIOD COVERED: October 1, 1982 to September 30, 1983

BACKGROUND

During FY 79, the fauna of Masso Reservoir and its feeder streams was sampled. Aquatic organisms collected include two eels (Anquilla mormorta and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis) an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates.

RESULTS

This job was largely inactive during the report period.

RECOMMENDATION

This job should be continued at a relatively low level to allow occasional monitoring of the Masso watershed.

Report prepared by: Michael E. Molina

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-5
SUBPROJECT NO: FD-1

JOB TITLE: Masso Reservoir Development

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

During FY 83 steps were taken toward officially opening reservoir to the public for sportfishing. Although an opening ceremony involving several federal and local government representatives was planned, it had to be aborted primarily because of incidents of illegal fishing and vandalism. In addition, approximately 75% of the Masso watershed was devastated by wildland fire during the early summer. Aside from these difficulties, grounds maintenance proved to be a problem due to inadequate local funding. For all of these reasons, the Masso project was temporarily given a low priority status until corrective measures in the areas of security and grounds maintenance could be resolved. With no workable resolutions in sight by the end of FY 83, the decision to close the project with Segment 5 was reached.

BACKGROUND

Fishing has always played a significant role in Guam's history as a source of food and, more recently, as a highly desirable recreational activity. While saltwater fishing opportunities abound on Guam, freshwater fishing opportunities have always been quite low due to limited resources and problems with public access. The creation of a fishable body of freshwater that is accessible to the general public would be a positive step in the development of recreational freshwater fishing on Guam. It would also be unique in providing fishing opportunities to children, senior citizens and the handicapped who may be unable to fish in the ocean where high waves and strong currents are often present. The rehabilitation of an unused, existing facility is one way to obtain a great deal of recreational benefit with only a minimum of environmental disturbance. During the early 1970's the Division of Aquatic and Wildlife Resources (DAWR) formally proposed that such a project be undertaken at the Masso Reservoir, located near the village of Piti, Guam.

Masso Reservoir was constructed by the U.S. Navy in the early 1940's to store potable water. It was abandoned in 1951 when siltation had made it unsuitable for water storage. Vegetational succession continued until only $\frac{1}{4}$ to $\frac{1}{2}$ acre of open water existed within a marsh of elephant grass (*Phragmites karka*). Although the U.S. Navy retains ownership of the reservoir and 26 acres of surrounding land, management of the aquatic and

wildlife resources contained therein has been turned over to the Government of Guam. In 1978, as part of the DAWR Fisheries Development Program, about two and one half acres of open water was created in the reservoir by removing the elephant grass and dredging to a maximum depth of approximately eight feet. At the same time the retaining wall, spillway and sluice gate were repaired.

Since that time, however, erosional siltation has been a continuing problem because much of the associated watershed contains only sparse vegetation. While elephant grass dominates the wetland vegetation, Leucaena leucocephala (tangan-tangan) is the most widespread plant found on dry ground. Other trees in the area include Hibiscus tiliaceus, Pandanus sp., Spathodea campanulata (African tulip), Casuarina equisetifolia (ironwood) and Pithecellobium dulce. Repeated efforts to control hillside erosion by planting thousands of tree and shrub seedlings have been only moderately successful, primarily due to poor soil quality. Although plantings were made during 1978, 1980 and 1981, only 10-20% of the plants had survived to the end of FY 82.

Aquatic organisms observed in Masso Reservoir and its feeder streams include two eels (Anguilla marmorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans and Sicyopterus macrostetholepis) an eleotrid (Elotris fusca), several shrimps (Atya sp., Caridina sp. and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates. In March 1978, a Draft Environmental Impact Statement (DEIS) and proposal to introduce exotic fish into Masso Reservoir was submitted to the U.S. Fish and Wildlife Service (FWS). FWS determined the DEIS to be inadequate in its treatment of potential problems and suggested that the process required to complete an acceptable EIS would be far more costly than the project warrants. In view of this decision, and after considering numerous professional evaluations of stocking, DAWR decided to abandon the proposal.

Alternatively, in 1980 and 1981 Masso Reservoir was stocked with species of fish already existing on Guam. These species include hybrid tilapia (Oreochromis mossambicus x O. nilotica), tucunare or "peacock bass" (Chichla ocellaris) and mosquitofish (Gambusia sp.). This combination should provide good recreational fishing. The tilapia are relatively easy to catch and will be particularly well suited to younger fishermen. The tucunare is a much more challenging gamefish that should also forage on the tilapia to reduce the common problem of stunted growth in the latter species. The mosquitofish will provide forage for the two game species. Although poachers had poisoned the reservoir just after the first stocking, by the end of FY 82 the resident fish community there appeared to be growing.

During FY 82, prior to opening the reservoir to the public, water quality analyses were performed and final attempts to reduce shoreline aquatic vegetation were made. Sportfishing regulations and a Memorandum of Understanding (MOU) between the Department of Parks and Recreation (DPR) and the Department of Agriculture transferring grounds maintenance responsibilities to DPR were also finalized.

OBJECTIVES

The objectives of the Masso Project have included the following:

1. Create a pond with several acres of open water suitable for stocking with forage and game fish;

2. Repair the retaining wall, spillway and sluice gate;

3. Create a variety of fish habitats within the pond with brush shelters, rock piles, etc.;

4. Fence in the spillway area to remove an "attractive nuisance" which is potentially dangerous to children and others;

5. Landscape the area around the pond, and plant attractive fruit, shade, and ornamental trees and shrubs;

6. Stock the pond with fish;

7. Monitor the fish populations in the pond, and the fishermen's use of the pond.

RESULTS

Throughout the first eight months of FY 83 the reservoir was routinely visited approximately once every two to three weeks in order to assess the general condition of the area. However, before Masso Reservoir could be officially opened to the public a few items required attention. These included the final phase of stocking; developing specific techniques and schedules to monitor physico-chemical and biological (including stock assessment) parameters, as well as fishing participation, effort and catch; integrating security patrols and periodic surveillance into the Conservation Officers' schedule; fabricating and posting a sign at the reservoir entrance; and coordinating a grand opening ceremony among various federal and local government agencies.

During the first part of FY 83 a sign was fabricated, and specific management techniques were outlined. Although specific schedules for security patrols had yet to be finalized and stocking remained to be completed, steps were taken to coordinate an opening ceremony. However, the November 1982 gubernatorial election produced a change of administration that resulted in temporarily delaying the ceremony. Before the new governor could commit himself to a specific time for the opening, DAWR received a report that one of the streams feeding the reservoir had been chlorinated by poachers. During a subsequent investigation no tilapia, mosquitofish or tucunare were observed in the pond. At that time (February 1983) a decision was made not to finish stocking the reservoir until adequate security could be provided and the opening ceremony was cancelled. Shortly after this the staff biologist assigned to the Masso project moved to the mainland to pursue work in the private sector.

Vandalism continued to plague Masso during the spring of 1983 when many of the remaining trees and shrubs planted to help control erosion were

stolen. To worsen matters further, the 1983 dry season on Guam was one of the driest on record, during which an unusually high number of wildland fires were recorded. One fire that occurred during the early summer burned over an estimated 1000 acres, including 75% the Masso watershed. An on-site inspection revealed that the fire had burned right to the edge of the reservoir destroying all but a few acres of land (primarily at the western end) surrounding the pond. Due to this unfortunate chain of events, DAWR decided to temporarily place the Masso Reservoir Development project into a relatively low priority status.

Aside from the setbacks just mentioned, grounds maintenance at Masso proved to be a problem due to inadequate FY 83 Department of Parks & Recreation funding. Thus, even if poaching, vandalism and wildland fires had not so adversely impacted the area, and the reservoir had been opened to the public, there would have been no maintenance performed on the grounds during the entire year. Unless the Government of Guam can increase Department of Parks & Recreation's funding level, adequate grounds maintenance at Masso will be questionable. Fortunately, however, the Guam chapters of the Boy Scouts of America and the 4-H Club have expressed interest in the reservoir. However, this interest was shown just prior to the end of FY 83, and at that time it was relatively vague.

The combination of problems encountered during FY 83 have led us to reassess the Masso Reservoir Development project. We still maintain that such a project is a desirable step in developing recreational freshwater fishing on Guam. However, the relatively small size of the Masso fishing pond makes it extremely vulnerable to the destructive effects of illegal fishing with poisons. Furthermore, the current situation with inadequate security and maintenance prevents us from proceeding further since continued funding within the DJ Fisheries Development program at this time is viewed as negatively cost-effective. Therefore, we have decided to close this project with Segment 5 and work toward resolving these problems through technical guidance.

RECOMMENDATIONS

This job should be terminated until problems with security and grounds maintenance are resolved. DAWR will continue to investigate the possibility of coordinating future maintenance and management functions among the Boy Scouts, the 4-H Club, DPR and our office through technical guidance. The project will be reopened only when we are satisfied that continued funding is justified on the basis of cost-effectiveness.

Report prepared by: Michael E. Molina

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: TERRITORY OF GUAM

PROJECT NO.: F-2-D-5
SUB-PROJECT NO.: FD-2

JOB TITLE: Construction of Fish Aggregating Devices (FADs)

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

No new FAD deployments or redeployments were made during FY 83. Only one FAD remained on-site between 1 October 1982 and 8 April 1983. Data from random samples of anglers returning to the Agana Boat Basin during that period showed that the FAD was used by a majority (60%) of those interviewed. The overall catch rate for those sampled (6.5 Kg/boat-hour) was very similar to that for the average troller who used the Agana Boat Basin (6.7 Kg/boat-hour) during FY 83. However, for those who fished the FAD an increase in catch rate of approximately 60% was realized (5.2 vs 8.4 Kg./boat-hour) for the time spent near the FAD compared with fishing done away from it in other nearshore waters. Based on the data gathered and the positive response Guam's recreational trollers gave to this project, we feel that it should be continued at a time when sufficient improvements to the mooring system design are made so that FAD-longevity is no longer considered negatively cost effective.

BACKGROUND

Low nutrient levels in tropical oceanic waters result in correspondingly low productivity with pelagic fishes being thinly scattered over wide areas Fishers in the tropics are faced with several problems which include: large amounts of time wasted searching for pelagic fish offshore, the inability to reach pelagic fish in unsheltered rough waters, and usually low concentrations of both pelagic and reef fish in any particular area. Cork rafts in Malta, and bamboo rafts in Japan and the Philippines, have been used for centuries by fishers to aggregate coastal pelagic fishes and improve their catches. These rafts capitalize on the behavior of certain pelagic fish, like tuna, to aggregate under floating objects. One explanation of such behavior hypothesizes that small fishes congregate around the floating object for protection and these in turn attract larger predatory species. Other possible explanations are that some pelagic fishes may use the objects as cleaner stations, spawning substrates or points of reference in an otherwise rather vacuous environment.

In 1977, the National Marine Fisheries Service in Hawaii experimented with the concept of using "permanently" moored offshore fish aggregating devices (FADs). Their objective was to determine if it was possible to attract, aggregate and hold pelagic fish schools in the FADs vicinity to

improve catch rates. Since the initial Hawaii project, several Pacific islands including American Samoa, Palau, the Northern Marianas and Guam have initiated similar offshore FAD programs. Construction of offshore FADs on Guam began in 1979 as a result of a $21,500 grant from the Pacific Tuna Development Foundation, and was later continued as part of the Dingell-Johnson Fisheries Development program. This project was expected to enhance the quality of the recreational fishing experience available on Guam through increased catches and reductions in the time lost searching for fish. Around the island of Guam and its associated shallow banks, common sportfish include migratory tunas, dolphinfish, billfish and rainbow runners, as well as a wide variety of resident reef fishes.

Detailed descriptions of the various FAD designs utilized on Guam were given in DAWR's FY 80 Annual Report. In FY 79, three Type I FADs were fashioned after Hawaii's three, 55-gallon drum design. Five "large tire" Type II FADs were constructed during FY 80. Of these, two Type I and one Type II FADs were deployed. One Type I FAD that broke loose was redeployed. Four Type III FADs, referred to as "small-tire" Type II FADs in the FY 80 report, were built and deployed during FY 81. New mooring systems were fabricated for two previously deployed FADs, and these FADs were redeployed during FY 82. In addition, a General Permit good for 10 years (until April 1992) was obtained from the U.S. Army Corps of Engineers, eliminating the need for repeated permit renewal. By the end of FY 82 all but one of our deployed buoys had been lost primarily due to problems with the mooring system design and materials. Mooring systems were periodically improved with the use of heavier polypropylene line, ball-bearing swivels and rubber-coated splices, shackles and swivels. Detailed description of the design evolution of Guam's FADs and criteria for site selection have been presented in DAWR's Annual Reports from FY 79 through 82.

Data on buoy fishing success was collected primarily in two ways: by handing out self-addressed FAD catch cards and conducting angler interviews. Initially, these methods provided only sparse data on fishing success but became much more productive during FY 82. Limited data indicate that Guam's FADs are effective in increasing catches, although longevity remains a problem. Observational dives made beneath the buoys provided information on the species and behavioral characteristics of fish associated with the FADs. Over twenty fish species have been observed beneath the FADs and these comprised seven juvenile or young adult reef species, five pelagic baitfishes and seven predators, four of which were recreationally important species of troll fish. Other recreationally important species have been caught within the vicinity (1 mile) of the FADs.

OBJECTIVES

1. To aggregate recreationally important pelagic fishes at point locations accessible to fishermen.

2. To perform routine maintenance and make observations on the FADs on a monthly basis.

3. To monitor the catch rate and catch composition of fishing done near the FADs.

PROCEDURES

The only FAD that was in place during FY 83 was located near Haputo Point and was originally deployed on 17 July 1981. This FAD was visited monthly for routine maintenance which entailed changing the warning light or battery, checking the upper portion of the mooring system and removing any lost fishing lures and lines which may have entwined the balast pole or mooring chain. Observations on the species of fishes visibly present near the FAD were recorded also during these visits.

Data on FAD fishing success were compiled during regularly scheduled offshore creel censuses (see Study No. F-1, Job 1) conducted at the Agana Boat Basin. On a particular census day a randomly chosen subsample of returning anglers were also asked if they had fished the FAD. If the reply was yes, they were further interviewed about their FAD-related effort and catch for that day only.

RESULTS

At the beginning of FY 83 only the previously deployed Haputo Point FAD (Type III) remained in place (Figure 1). No new deployments or redeployments were made during the year. The Haputo Point FAD was finally reported lost on 8 April 1983.

Table 1 presents a summary of FAD deployments since the beginning of the program in FY 79. Eight buoys have been constructed and ten deployments have been made. FAD longevity has ranged from 7 to 640 days with a mean of 170 days. This mean life span compares well with that reported for FADs of various designs, from 26 locations throughout the Pacific Region (157 days), (Shomura and Matsumoto, 1982). Of the 10 instances of Guam's FADs breaking loose, we believe all but two were due to failures of the mooring systems. The exceptions were the Cocos Island FAD, which we believe slipped into deeper water and submerged, and the Apra Harbor FAD which undoubtedly was released when a motor vessel severed line scope at the surface. Longevity of Type III buoys, with improved mooring systems, averaged over five times that of the original Type I buoys (370 days vs 65.8 days).

Table 2 summarizes the fish species observed beneath all of Guam's FADs since FY 80. Reef fishes as well as pelagics have commonly been seen. Different groups appear to occupy different ranges around the FADs, and may be attracted to the buoys for different reasons. Readers are referred to DAWR's FY 81 Annual Report for further details and explanations.

Between 15 October 1982 and 29 March 1983, a total of 127 recreational/subsistence trolling parties returning to the Agana Boat Basin were asked if they had fished the Haputo FAD that day. A summary of the results of these interviews is presented in Table 3. Seventy-eight (60%) of the parties responded that they had fished the FAD for a combined landed catch of 490.1 kg. Effort expended at the FAD was reported as either the numbers of passes made (n=63) or the number of boat-hours spent fishing (n=41). From the latter, line-hours of effort could be calculated. The average amount fishing effort expended at the FAD was to troll four lines for about one hour. In terms of the number of passes made at the FAD,

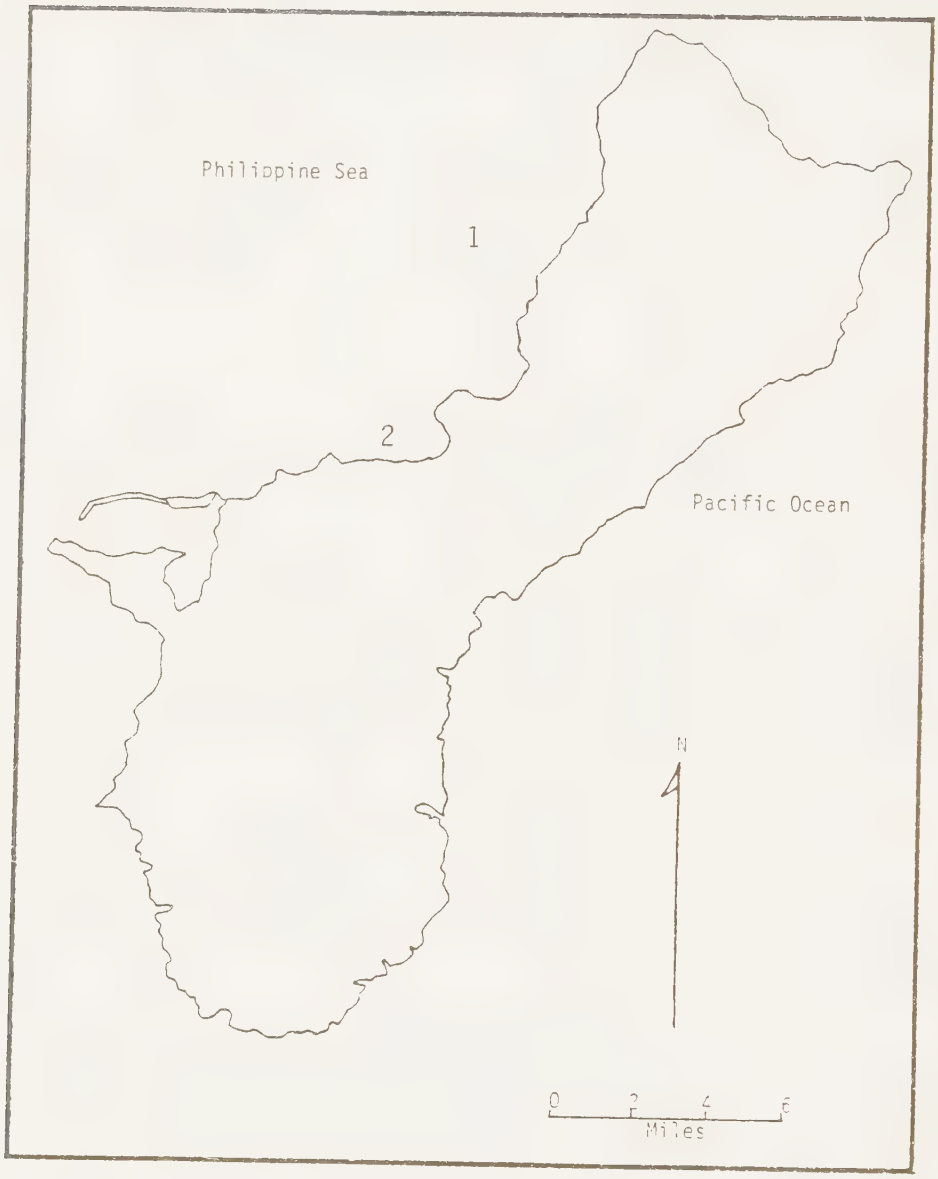


Figure 1. The island of Guam showing the approximate location of the Haputo Pt. FAD. 1 = Haputo Pt. FAD; 2 = Agana Boat Basin.

Table 1: Locations, deployment dates and longevity of Fish Aggregating Devices (FAD) in Guam FY'79-83.

Location	FAD Design*	Depth (Fathoms)	Date Deployed	Approximate Date Lost	Longevity (days)	Latitude (Approximate)	Longitude (Approximate)
Buoy A : Facpi Pt.	I	570	12/8/79	12/14/79**	7	13°20.2'N	144°36.4'E
Buoy A : Facpi Pt.	II	570	4/24/80	9/13/80**	142	13°20.2'N	144°36.4'E
Buoy A : Facpi Pt.	III	570	5/18/81	7/10/82	226	13°20.2'N	144°36.4'E
Buoy B : North End	I	200	6/23/80	9/13/80	82	13°43.1'N	144°53.7'E
Buoy H : Cocos Island	III	600	5/18/81	Believed Sunk	-	13°14.0'N	144°37.4'E
Buoy J : Haputo Pt.	I	500	1/30/80	5/5/80	94	13°37.1'N	144°46.5'E
Buoy J : Haputo Pt.	III	500	7/17/81	4/8/83	640	13°57.1'N	144°46.5'E
Buoy K : Camel Rock	III	500	7/16/81	3/15/82	242	13°14.0'N	144°37.4'E
Buoy L : Apra Harbor	II	1000	3/13/82	3/30/82	15	13°32.1'N	144°36.9'E
Buoy M : Ritidian	I	500	3/14/82	6/1/82	80	13°42.6'N	144°36.9'E

*Design I = Triple 55-gal drum buoy; II = Large Tire Buoy; III = Small Tire Buoy
**Buoy Retrieved

Table 2. Fish species seen near Guam's FADs since FY 80. These species are divided into reef fish species (R), baitfish types (B), troll species predators (T), other predators (P) and others (O). Species are further classified according to FAD association patterns as small home range regulars (shr), large home range regulars (lhr), irregulars (ir) and refugees (rf). These catagories are explained in the FY 81 Division of Aquatic and Wildlife Resources annual report.

Scarus venosus (R,rf)
Aspidontus taeniatus (R,rf)
Monocanthidae sp.1 (R,rf)
Monocanthidae sp.2 (R,rf)
Kyphosus cinerascens (R,rf)
Aulostomus chinensis (R,rf)
Exocoetidae (B,ir)
Decapterus pinnulatus (B,lhr)
Caranx sexfaciatus (B,shr)
Psenes cyanophrys (B,shr)
Coryphaena hippurus (T,lhr)
Acanthocybium solandri (T,ir)
Elagatis bipinnulatus (T,lhr)
Hemiramphidae sp. (B,ir)
Selar crumenophthalmus (B,ir)
Canthidermis maculatus (O,shr)
Antennariidae sp. (O,shr)
Mullidae sp. (R,rf)
Carcharchinus melanopterus (P,ir)
Ablennes hians (P,ir)

Table 3. Summary of FAD-related data gathered from a random interview sample of trolling parties returning to the Agana Boat Basin, Guam, between 15 October 1982 and 29 March 1983.

	No.	% or "n"
Fishing parties interviewed	127	100%
Fished FAD	76	60%
Did not fish FAD	51	40%
Kg caught near FAD	490.1	n=76
Avg. FAD Boat-Hrs/Trip	1.0	n=41
Avg. FAD Line-Hrs/Trip	4.4	n=41
Avg. FAD Passes/Trip	4.4	n=63
Avg. Minutes/FAD Pass	8.8	n=32
Kg caught/FAD Boat-Hr	8.4	n=41
Kg caught/FAD Line-Hr	2.0	n=41
Kg caught/FAD Pass	1.3	n=63

the average boat made four to five passes, lasting about nine minutes each, per trip.

The overall trolling catch rate for the 127 fishing parties, combined was 6.5 Kg/boat-hour (Table 4), very similar to the 6.7 Kg/boat-hour catch rate calculated for all trollers interviewed from our offshore creel census program (See Study F-1, Job 1) during the same period. However, among the parties that reported fishing effort at the FAD in terms of boat-hours (n=41), a catch rate of only 5.9 Kg/boat-hour was attained. This appears even more surprising when compared to the catch rate of 8.4 Kg/boat-hour calculated for the sampled boats that reportedly did not fish the Haputo FAD at all (n=51). In order to keep these values in perspective one must realize that half of the latter group targeted their effort at the more productive offshore banks (n=23). In doing so, these individuals did not specifically attempt to locate and spend time fishing near the FAD, and most spent only a small amount of time fishing the nearshore waters around Guam. Among those sampled who did not fish either the FAD or the banks (n=28), a catch rate of 5.3 Kg/boat-hour was achieved.

A more realistic way of assessing FAD fishing success may be to compare the catch rates among those who did use it, either solely or in combination with fishing done in other relatively nearshore waters. For their effort, this group harvested 5.2 Kg/boat-hour while fishing Guam's nearshore waters away from the FAD, but took 8.4 Kg/boat-hour while deliberately fishing near it (within 1 mile). This represents more than a 60% increase in catch rate for the time they spent fishing the FAD.

Among those who reported FAD fishing effort in terms of the number of passes made near the buoy an average of 1.3 Kg/pass were harvested. Within the entire FAD catch that was reported, Mahimahi (Coryphaena hippurus) formed the largest portion (58.5%) by weight. Wahoo (Acanthocybium solandri) (20.4%) and skipjack tuna (Katsuwonus pelamis) (18.3%) were also important, while yellowfin tuna (Thunnus albacares) (2.8%) contributed only a small part of the total catch. The best single FAD catch reported in FY 83 totaled 52.3 Kg (mostly mahimahi) taken in 1.5 boat-hours. This represents a catch rate of 34.9 Kg/boat-hours! On the other hand, however, 42% (33) of the trips made to the FAD resulted in zero catch.

RECOMMENDATIONS

The results of this program have shown the FADs to be effective in aggregating recreationally important pelagic fishes at point locations in the relatively nearshore waters of Guam. Data analyses have demonstrated that overall catch rates may be improved when FAD-fishing is utilized. Interviews with anglers have provided positive testimony in favor of the FAD program. Based on this DAWR feels that the development of recreational saltwater fishing on Guam should be continued through the use of FADs.

However, until FAD-longevity can be increased, the overall cost effectiveness of the program is questionable. We feel that further construction and deployment of FADs in Guam's waters should be delayed until technological improvements in the mooring system are realized. Once

Table 4. Summary of effort, catch and CPUE calculated for trolling boats that were sampled for FAD fishing at the Agana Boat Basin, Guam, between 15 October 1982 and 29 March 1983. Note: only 41 of the 76 boats that fished the FAD reported their FAD effort in terms of boat-hours.

	Effort (Boat-Hrs)	Catch (Kg)	Kg/Boat-Hr
Boats that fished the FAD (n=41):			
Total	215.6	1263.4	5.9
FAD only	43.2	361.7	8.4
Non-FAD	172.4	901.7	5.2
Boats that did not fish the FAD (n=51):			
Total	268.2	2260.1	8.4
Banks only	162.0	1693.9	10.5
Non-Banks	106.2	566.2	5.3
All boats sampled (n=127):			
Total	668.8	4339.7	6.5

the mooring system design study, now in progress by the U.S. Coast Guard, is completed the program may proceed; but for now DAWR recommends that this subproject be terminated with Segment 5. During the interim funding for future FAD work will be sought from other sources.

REFERENCES CITED

Shomura, R.S. and W.M. Matsumoto. 1982. Structured Flotsam as Fish Agregating Devices. NOAA Technical Memorandum, October 1982. NOAA-TM-NMF-SWFC-22. 9 pp.

Report prepared by: Michael E. Molina

AQUACULTURE

Funding Source: National Marine Fisheries Service
(P.L. 88-309)
Government of Guam

PROJECT TITLE: Development of Tropical Polyculture Fish Farming

PERIOD COVERED: October 1, 1982 through September 30, 1983

OVERVIEW

During FY 83, work remaining to be done on the new aquaculture facility at the Division of Aquatic and Wildlife Resources was accomplished with the installation of several plumbing parts and a cyclone fence for security. Although the plumbing system appeared to be functioning properly, we felt it prudent to monitor it over a period of time with stocked fish before any formal research was undertaken. In order to accomplish this, several activities were designed to utilize the various tanks. The largest tanks (3975-litter and 2082-liter) were used for holding adult broodstock of the following species: local tilapia (Oreochromis mossambicus), hybrid tilapia (O. mossambicus x O. niloticus) and Guam catfish (Clarius macrocephalus). Some of the smaller tanks (1136-liter and 757-liter) and troughs (378-liter and 125-liter) were utilized to produce and grow tilapia fry.

After the tank and plumbing system was found to be functioning reliably, and after the stocked fish were observed to behave compatibly with the system, greater emphasis was directed at developing a practical technique for the induced spawning and production of Guam catfish. What follows is a short report on the system check-out phase and a more detailed report on the artificial reproduction trials performed on the Guam catfish.

I. TANK AND PLUMBING SYSTEM MONITORING WITH FISH IN PLACE

SUMMARY

Four 1136-liter tanks were each stocked with one male and two female local tilapia (O. mossambicus) and observed for 12 weeks after which a total of 408 fry were produced. In addition, four 757-liter tanks were each stocked with two female local tilapia (O. mossambicus) and one male hybrid tilapia (O. mossambicus x O. niloticus). Observation of this system lasted 13 weeks by which time 1283 fry had been produced. Two groups of fry produced in the 1136-liter tanks were individually stocked into two 125-liter troughs and observed for 10 weeks. At that time the groups of fry were moved to two 378-liter troughs and observed for five more weeks. Throughout the observation period, the tanks, troughs and plumbing system were found to be in good working condition. During that time, all but one of the brooder tilapia appeared to be healthy and behaving normally. The mean growth rate (0.27 cm/wk) recorded for the fry up to 15 weeks in age is consistent with data reported elsewhere.

OBJECTIVE

To monitor the long-term functioning of the recently installed tank and plumbing system at the Division's new aquaculture facility and to make a general assessment of the level of system compatibility displayed by stocked fishes through limited observations on their survivability, reproduction and growth.

PROCEDURES

A portion of the new system was run for a period of time without stocked fish to make sure there were no structural problems in its functioning. When satisfied of this, we introduced fish into the system. Local and hybrid adult tilapia were placed into one 2082-liter fiberglass tank and three 3975-liter fiberglass tanks to serve as a main broodstock. Four round 1136-liter fiberglass tanks, each containing a substrate of five centimeters of clean Pennsylvania sand, were stocked with local tilapia at a male to female ratio of 1:3, and observed for 12 weeks. All brooders were less than 20 cm in total length at stocking. In addition, four round 757-liter fiberglass tanks were each stocked with two female local tilapia brooders and one male hybrid tilapia brooder. The total lengths of these fish were all less than 22 cm. The bottoms of these tanks were kept barren throughout the observation period which lasted 13 weeks. During the observation period two groups of newly-hatched fry were collected from the 1136-liter tanks and placed into separate 125-liter fiberglass rearing troughs. On the tenth week, each group of fry was placed into its own slanted 378-liter trough. Every three weeks, during a 15 week period, the total lengths of 10 fish were measured from each group.

RESULTS

During the entire monitoring period, the tanks, troughs and plumbing system were found to function properly. Although some mortality did occur, the majority of the brooders, fry and fingerlings appeared to be healthy and behaving normally throughout the observation period. Construction and maintenance of circular nests, were observed continuously in the 1136-liter tanks. Although three or four nests were constructed in each of these tanks, only 408 fry were produced during the entire 12-week period. Brooders held in the 757-liter tanks with barren substrates appeared to behave normally, although they did not reproduce until the last week of observation. Approximately 1,283 fry were produced in three distinct hatches. The two groups of fry that were reared to fingerlings in the absence of adult brooders also fared relatively well (Table 1). The mean total lengths of the sampled fry increased from 0.75 cm in both groups to 5.66 cm in Group I and to 3.83 cm in Group II. An average growth rate of 0.27 cm/wk was exhibited.

DISCUSSION

Throughout the monitoring period, the new tank and plumbing system performed well. The vast majority of the stocked fish survived and behaved normally, showing no signs of the possible presence of toxic residues left over from tank or trough construction. Even with the relatively low level of production that occurred during the observation period, sufficient numbers of new fry were produced to easily supply a backyard type tilapia farm.

Table 1. Mean growth of two groups (I and II) of local tilapia (Oreochromis mossambicus) fry raised on artificial feed in the absence of adult broodstock from March 4 to July 6, 1983.

	Week 1		Week 3		Week 6		Week 9		Week 12		Week 15	
	I	II	I	II	I	II	I	II	I	II	I	II
	3/6/83	3/29/83	3/25/83	4/12/83	4/15/83	5/3/83	5/6/83	5/24/83	5/27/83	6/14/83	6/17/83	7/6/83
Total Length (cm):												
	.75	.75	2.0	1.25	3.0	1.7	2.7	2.6	4.0	3.0	6.0	5.0
	.75	.75	2.0	1.4	2.4	1.9	3.1	2.4	3.5	2.2	6.5	3.5
	.75	.75	1.7	1.4	2.6	1.9	3.0	2.3	4.0	2.8	5.3	3.9
	.75	.75	1.5	1.3	3.0	2.0	2.9	2.1	4.2	2.5	5.0	4.4
	.75	.75	1.5	1.4	2.7	1.8	3.4	1.9	3.6	2.3	5.2	4.1
	.75	.75	1.4	1.0	2.1	1.6	2.9	2.3	3.8	1.9	6.8	3.0
	.75	.75	1.4	1.1	2.5	2.0	3.4	1.9	4.0	2.8	5.5	3.6
	.75	.75	1.3	1.0	2.4	2.1	3.1	1.7	4.0	2.5	4.8	3.6
	.75	.75	1.4	1.1	2.5	1.7	3.2	1.9	3.2	2.9	6.0	3.8
	.75	.75	1.4	0.9	2.3	1.6	2.8	2.2	4.5	2.7	5.5	3.4
Mean Total Length (cm):	.75	.75	1.57	1.18	2.55	1.83	3.05	2.13	3.88	2.56	5.66	3.83
Mean Growth By Group (cm):			.82	.43	.98	.65	.50	.30	.83	.43	1.78	1.27
Mean Growth Overall (cm):	-		.62		.82		.40		.63		1.52	

RECOMMENDATIONS

Based on our observations we are confident that the recently installed tank and plumbing system at the Division's new aquaculture facility is structurally sound and capable of functioning properly during formal research. Fish stocked in the system appear to reproduce, grow and behave normally. We feel that water flow rates should be closely monitored in order to maintain water quality that is optimal for growth and survival. The installation of a viable chlorine filter system would further safeguard water quality.

II. ARTIFICIAL REPRODUCTION OF THE GUAM CATFISH, CLARIUS MACROCEPHALUS

SUMMARY

Three artificial reproduction trials were conducted on Clarius macrocephalus, using injections of human chorionic gonadotropin to induce egg and sperm development. The successfulness of the trials lies in the experience gained from their execution as it will contribute to the development of a practical technique for artificial reproduction that may be utilized by local fish farmers with a minimum of equipment and training. As various methods were tried and evaluated, certain procedures were either discarded or retained. Adequate preparation, efficient execution and cleanliness were found to be overriding factors influencing successful fertilization and hatching.

OBJECTIVE

To develop a practical technique for the artificial reproduction of the Guam catfish, Clarius macrocephalus.

PROCEDURES

Preinjection Handling

Three artificial reproduction trials were conducted. In most respects, the fish handling methods used in these trials were very similar, however, slight differences did occur in the level of hormone dose used, the number of hormone injections given, the treatment of milt just prior to egg fertilization and the incubation of fertilized eggs. In each trial, eight male/female pairs were measured, weighed and placed into individual 189-liter holding troughs each containing approximately 72 liters of water. A clear plastic tube etched with centimeter markings was used to measure total lengths, and a triple-beam balance was used to record fish weights. Each holding trough was covered with plastic mesh to prevent the fish from escaping during the night.

Injection Handling

On the following day injections of human chorionic gonadotropin (HCG) hormone were administered to the fish according to the schedules outlined in Tables 2, 3 and 4. Control fish were injected with 0.9% saline solution at a rate representing the average amount of HCG given to the other fish. In the first two trials, each fish received two injections six hours apart, comprising one-third and two-thirds of the total dose, respectively. In the third trial, a single dose was administered. The injections were made into dorsal intermuscular tissue just above the lateral line. After the injections were administered, the fish were returned to their holding troughs.

Artificial Fertilization

Artificial fertilization among each pair of fish was performed on the following morning. An attempt was made to extract the male testes, obtain milt, strip eggs from the female and fertilize the eggs all within 60 seconds. In each case, the male testes was removed from the fish, washed, and cut into very small bits to create a sperm solution. In the first trial, the testes were washed and cut up in a 0.9% sodium chloride solution. In the following trials, the testes were washed in saline and cut into a solution made from four grams of sodium chloride and three grams of urea in 1000 ml of distilled water. While the sperm solution was being made, eggs were gently stripped from the female into a clean glass dish. The sperm solution was poured over the eggs, gently mixed and allowed to sit for approximately three minutes. The fertilized eggs were then placed into prefabricated egg baskets after being washed with saline solution.

Incubation

In the first trial, the fertilized eggs were placed into compartmentalized baskets lined with fine-mesh nylon cloth which were suspended at one end of a slanted 378-liter trough. Water entering the trough was carbon-filtered and flowed at a rate of approximately 3.5 l/min. In the second and third trials, the fertilized eggs were placed into similar nylon-mesh baskets which were suspended in glass aquaria inside the laboratory to maintain more uniform temperature conditions. In all trials, the eggs were suspended in one to two centimeters of water. In the aquaria, water was circulated and aerated by a standard corner filter with an attached electric air pump. In all trials, water quality was monitored for oxygen and chlorine using a Hach Kit.

RESULTS

Nearly all of the catfish used in the three trials had either a dark, pink-colored papillae or a reddish-colored vent. The hormone-injected males had noticeably enlarged testes which were highly vascularized and which generally appeared to contain more milt. Hormone-injected females had darker eggs, which flowed easier and generally appeared

Table 2. Human chorionic gonadotropin (HCG) injection schedule administered to *Clarius macrocephalus* on August 2, 1983. Injection 1 was given at 1000 hrs and Injection 2 was given at 1600 hrs. Tank 1 = control.

Tank	Sex	Total Length (cm)	Weight (gms)	Injection Rate (IU/gm)	Total Injection (IU)	Injection 1		Injection 2	
						0.9% Saline Solution (IU)	HCG (IU)	0.9% Saline Solution (IU)	HCG (IU)
1	Male	20.5	60.2						
	Female	21.0	66.9						
	Male	22.0	75.3		360	120	-	240	-
	Female	21.5	75.5						
2	Male	23.0	75.8		227		76		151
	Female	24.5	109.7	3	329	-	110	-	219
	Male	20.0	54.4		163		54		109
	Female	24.0	107.0		321		107		214
3	Male	22.5	74.2		297		99		198
	Female	23.5	91.9	4	368	-	123	-	245
	Male	24.0	88.7		355		118		237
	Female	28.5	175.0		700		233		467
4	Male	23.0	86.0		430		143		287
	Female	24.0	105.7	5	529	-	176	-	353
	Male	21.0	57.8		289		96		193
	Female	20.0	62.3		312		104		208

Table 3. Human chorionic gonadotropin (HCG) injection schedule administered to Clarius macrocephalus on August 9, 1983. Injection 1 was given at 1000 hrs and Injection 2 was given at 1600 hrs. Tank 1 = control.

Tank	Sex	Total Length (cm)	Weight (gm)	Injection Rate (IU/gm)	Total Injection (IU)	Injection 1		Injection 2	
						0.9% Saline Solution (IU)	HCG (IU)	0.9% Saline Solution (IU)	HCG (IU)
1	Female	22.5	101.1						
	Male	20.0	60.6		392	131	-	261	-
	Male	22.0	84.1						
	Male	21.0	70.6						
2	Female	22.0	98.1		392		131		261
	Male	21.0	67.8	4	271	-	90	-	181
	Male	23.0	87.2		349		116		233
	Male	18.0	63.8		255		85		170
3	Female	20.0	71.8		359		120		239
	Male	21.0	67.9	5	340	-	113	-	227
	Male	21.0	72.4		362		121		241
	Male	20.5	65.3		327		109		218
4	Female	23.0	92.1		552		184		368
	Male	22.0	83.1	6	499	-	166	-	333
	Male	25.0	103.3		620		207		413
	Male	20.5	63.6		381		127		254

Table 4. Human chorionic gonadotropin (HCG) injection schedule administered to Clarius macrocephalus on September 27, 1983. A single injection was given at 0900 hrs.

Tank	Sex	Total Length (cm)	Weight (gm)	Injection Rate (IU/gm)	Total Injection 0.9% Saline Solution (IU)	Total Injection HCG (IU)
1	Male	19.5	56.0			
	Female	19.0	55.4		271	
	Male	19.5	56.9			
	Female	20.5	61.3			
2	Male	21.0	62.5			188
	Female	19.5	55.5	3		167
	Male	20.5	67.6			203
	Female	20.5	56.4			169
3	Male	20.0	59.1			236
	Female	20.5	65.0	4		260
	Male	20.5	66.2			265
	Female	24.5	92.0			368
4	Male	23.5	91.5			458
	Female	21.5	74.3	5		372
	Male	20.0	61.4			307
	Female	18.0	52.8			264

to be more numerous. As measured during Trial I only, females produced between 3.8 and 12.6 grams of eggs per fish ($\bar{x}$ = 8.9 grams), with eggs ranging in approximate size from 0.75 to 1.50 mm.

During the incubation phases of each trial, unfertilized eggs were observed to turn a whitish color; these were removed with a small dropper as soon as possible. In Trial I (Table 2), only three dark brown eggs were noticed to have hatched in tank 4 at the 28th hour.

In Trial 2 (Table 3), most of the eggs appeared to be infected by a fungus after 21 hours. Between the 28th and 30th hours, however, approximately 100 eggs hatched in tank 3. By the 45th hour approximately 30 of these hatchlings had died, and only 15 fry remained alive after the 52nd hour. These fry were supplementally fed fresh boiled egg yolk and tropical fish food flakes after the 116th hour. At that time, pigmentation, eyes and a more distinctive caudal tail began to develop noticeably. The fry continued to grow and showed an increase in swimming behavior even though their yolk sacs were still attached. Unfortunately, after 141 hours all fry had died.

In Trial 3 (Table 4), all eggs were found dead on the 16th hour. The average water temperature recorded during all trials was 28.3°C, and no chlorine was ever detected. The average oxygen level recorded in the first two trials was eight parts per million, but in the last trial only four parts per million was recorded. A fungus was also found to be developing on the basket netting material during Trial 3.

DISCUSSION

The successfulness of these trials lies in the experience gained from their execution. While all of the hormone-injected fish responded positively to the HCG, it became quite apparent that adequate preparation, efficient execution and cleanliness were overriding factors influencing successful fertilization and hatching. As various methods were tried and evaluated, certain procedures were either discarded or retained in an effort to develop a technique which not only had a good chance of success, but which also could be employed relatively easily by local fish farmers with a minimum of equipment and training.

For example, after the first trial we felt that the time span between the stripping of the eggs and actual fertilization should be held to less than sixty seconds. Our major concern was that the micropyle opening on each egg might begin to close after more than one minute of exposure, thereby, reducing the chances of sperm cells entering during their period of peak motility. Also, the contents of the sperm solution that was used for fertilizing the eggs was somewhat modified after the first trial. We switched from a 0.9% saline solution to a salt-urea solution after becoming aware of documentation that the latter not only prevents eggs from sticking together, but also enhances the virility of sperm (Woynarovich 1975; Woynarovich and Horvath 1980).

Similarly, a step whereby the fertilized eggs were washed before they were placed into the incubation baskets was incorporated into the technique after the first trial. This occurred in response to our

observation of blood and bits of tissue, which are potentially excellent culture media for fungi, being mixed in with the fertilized eggs. Therefore, on subsequent trials the fertilized eggs were washed with a 0.9% saline solution in a funnel which was lined with a piece of clean, fine-meshed nylon cloth, before they were placed into the egg baskets.

Furthermore, we found it to be safer to incubate the eggs in baskets suspended in laboratory aquaria rather than suspended in unsheltered outdoor troughs. To illustrate, in Trial 1, the outdoor troughs were used. When we left for the first night of incubation, many of the eggs appeared viable, but during the night we experienced a heavy rain which lasted into the next day. Because the water temperature surrounding the eggs was lowered substantially by the rainfall, all eggs were found to have died by the following day. We also feel that the incubation baskets themselves should be fabricated simply of a single layer of fine-meshed nylon cloth. When double-layer fabrication was tried in Trial 3, we found that a fungus developed between the layers which appeared to seriously hamper proper water circulation, and could possibly have resulted in inadequate aeration of the eggs.

As can be seen in Tables 2, 3 and 4, sex ratios, hormone dosages and number of injections varied among the trials. Yet, because of the limited number of trials that were conducted, and the different procedures that were incorporated into each trial, optimum levels of these factors cannot be discerned. From our results, however, we do feel that an HCG hormone dose of 5 IU/gram of fish body weight administered in two injections with a six-hour interval, should provide a satisfactory response in milt and egg production. Moreover, a 1:1 sex ratio appears to be adequate as long as the artificial fertilization process is implemented quickly and efficiently, with sufficient attention given to cleanliness and non-contamination.

RECOMMENDATIONS

Further work is necessary to refine a practical technique for the artificial reproduction of the Guam catfish, Clarius macrocephalus. A result of further testing should be the development of clear step-by-step procedures for artificial fertilization and incubation which may be utilized by local fish farmers with a minimum of equipment and training. The application of this technique to other more commercially valuable species, such as C. batrachus and Pangasius sutchi, should also be investigated.

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Report prepared by: Wayne Kruckenberg

GUAM WILDLIFE INVESTIGATIONS
PROJECT FW-2R-20
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUBPROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

PERIOD COVERED: October 1, 1982 to September 30, 1983.

SUMMARY

Hunting license sales increased dramatically in FY 1983 as did hunter participation, hunter success, and legal harvest. An estimated 119 deer were taken during the 3 month season providing over 1500 days of recreation. A "special" control hunt was held at Andersen Air Force Base, the first since 1978. The most popular deer hunting areas on island were the special hunt on Andersen Air Force Base (AAFB), Northwest Field (NWF), Naval Communication Area Master Station (NAVCAMS) and the Bolanos Conservation Reserve. Analysis of the spotlight count data indicated a non-significant increase in deer numbers at AAFB and a non-significant decrease on Naval Magazine (NAVMAG).

BACKGROUND

The Guam deer has been under investigation by the Division of Aquatic and Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures.

OBJECTIVES

To determine the current size and distribution of the population of deer on Guam and to monitor population trends.

PROCEDURES

1. Continue monthly spotlight counts on Naval Magazine and Andersen Air Force Base, with periodic spotlight counts in other areas.

    a. Record number, age, sex and group compoition.

    b. Statistically analyze count data and compare with past data to discern population trends.

2. Investigate the feasibility of using additional census methods, such as pellet group counts, to refine population estimates and knowledge of distribution.

    a. Conduct surveys and censuses in areas such as the Bolanos Conservation Area, where spotlight counts are not feasible.

    b. Attempt to correlate spotlight count data with actual deer abundance on AAFB by determining the change in sex ratio after buck-only special hunts.

    c. Attempt to determine a pellet group index that may be used to estimate deer abundance and/or habitat utilization.

3. Collect hunting statistics by requiring hunters to return hunter report cards. Analyze these statistics for changes in hunter kill, hunter effort and kill locations.

4. Mail a harvest questionnaire to those hunters that did not return their hunter report cards after the close of the season.

RESULTS

Deer Hunting Statistics

Hunting license sale for all game species increased dramatically in FY 1983. A total of 467 hunting licenses was sold, an increase of 30.4% over the FY 1982 level. The regular deer season ran from October 1, 1982 to December 31, 1982, with a season bag limit of one antlered deer. A "special" either-sex control hunt was held on AAFB to reduce the Pati Point herd and lessen the safety hazard posed by deer on the runways. Special regulations were promulgated to allow a either-sex hunt on the last weekend in November and on weekends and holidays in December in designated areas near the flightline. Any hunter with an unused 1982 deer tag was eligible to participate in the hunt, with the daily participation selected by a lottery.

A return addressed, stamped hunter report card was handed out with each license sold with instructions to complete and return the card at the end of that year's hunting season. Of the 467 cards distributed, 42 (9.0%) were returned without further solicitation. To increase the number of hunters sampled, a second report card was mailed to 178 nonrespondents of the initial questionnaire. Sixty (33.7%) questionnaires were returned from the second mailing bringing the total number of reports returned to 102, 21.8% of all license buyers. Of the 102 respondents, 79 (77.5%) reported they actively hunted during the license year. Based on that proportion, the estimated total number of legal hunters in FY 1983 was 362.

Sixty-six of the 79 reporting hunters (83.5%) indicated that they hunted deer during the past season (Table 1). Twenty-six deer were reported taken by the 66 deer hunters yielding a success rate of 39.4%, an increase over FY 1982. The reported hunter kill was distributed in the following

Table 1. Island-wide deer hunting statistics for FY 1983.

a.	Total license sales for all game species	467
b.	Number of hunter reports/questionnaires returned	102
c.	Percent of license buyers reporting	21.8%
d.	Number of reporting license buyers (102) that hunted any species	79
e.	Percent of license buyers that hunted any species	77.5%
f.	Estimated total number of legal hunters	362
g.	Number of reporting hunters (79) that hunted deer	66
h.	Percent of reporting hunters that hunted deer	83.5%
i.	Number of deer taken by 66 deer hunters	26
j.	Hunter success (i ÷ g x 100)	39.4%
k.	Estimated total number of legal deer hunters (fxh)	302
l.	Estimated total legal deer take (jxk)	119
m.	Number of 8-hour days expended by 58 reporting deer hunters (2,312 total hours)	289
n.	Average number of 8-hour days spent per reporting deer hunter (m ÷ 58)	5.0
o.	Estimated total number of days spent hunting deer (kxn)	1510
p.	Number of 8-hour days spent hunting per deer taken (o ÷ l)	12.7

areas: AAFB-12, NWF-9, Bolanos Conservation Reserve-2, Tarzan Falls area-2, and private property-1. Deer hunters were also requested to provide information on their hunting effort. Fifty-eight hunters reported they spent 289 8-hour days pursuing deer, an average of 5.0 days in the field per hunter, 2.5 days less than the FY 1982 average.

The island military bases once again were the most popular hunting areas with 47% of the responding hunters reporting they hunted at AAFB, 39% at NWF, and 18% at NAVCAMS (Table 2). NWF received the heaviest hunting pressure with 619 hunter days spent there, followed by private lands at 234 days, NAVCAMS at 192 days and AAFB at 185 days. Of the territorial conservation reserves, Bolanos was the most popular hunting area with 16.7% of the reporting hunters hunting there, followed by Tarzan Falls which was hunted by 4.5% and Anao by 1.5% of the reporting hunter. An estimated 158 hunter days were spent in the 3 areas.

Estimates based on report cards indicated that 302 hunters hunted deer and 119 deer were harvested from the following areas; AAFB (55), NWF (41), Bolanos (9), Tarzan Falls (9) and private land (5), a substantial increase in both the number of hunters and the harvest over previous years (AWRD 1980, 1981, 1982). However, total hunter effort (number of days spent hunting deer) and average hunter effort decreased slightly in FY 1983 to 1510 total days spent hunting deer with an average of 5.0 days per hunter versus 1628 and 7.5 days in FY 1982. Likewise, the hunter effort expended per deer taken decreased in FY 1983 to 12.7 days spent hunting per deer taken versus 24.3 days in FY 1982.

Table 2. Deer hunting statistics broken down by popular hunting areas based upon hunter reports and questionnaires returned by 66 deer hunters for FY 1983.

Hunting locations	No. of hunters	% Deer hunters	No. days hunting	No. deer taken	% Hunter success	Estimated total days hunting	Estimated kill	Estimated effort/deer taken (days/deer)
AAFB	31	47.0	41	12	38.7	185	55	3.4
NWF	26	39.4	135	9	34.6	619	41	15.1
NAVCAMS	12	18.2	42	0	0	192	0	-
Bolanos	11	16.7	13	2	18.2	61	9	6.8
Tarzan	3	4.5	21	2	66.7	95	9	10.6
Anao	1	1.5	0.4	0	0	2	0	-
Private	8	12.1	51	1	12.5	234	5	46.8

Hunter logs were kept at AAFB, NWF, and NAVCAMS military installations with all hunters required to sign in and out and record any game taken. The log provided a fairly accurate record of hunting effort and take on those military installations upon which the accuracy of the hunter report cards can be compared. The data extracted from the official hunter logs is presented in Table 3. Comparing the actual deer take (official logs - Table 3) with the estimated take derived from the hunter report cards (Table 2), it is apparent that the kill figures derived from the hunter report cards are misleading. The estimated kill based on hunter reports is 1.6 times that of the official log figure at AAFB, 1.7 times that at NWF, and the official take at NAVCAMS was 2 animal versus no kill in the report cards.

Spotlight Count Trends

Monthly spotlight counts at AAFB (Table 4) and NAVMAG (Table 5) were continued in FY 1983. At AAFB, the average number of deer seen per count increased slightly from 66.4 in FY 1982 to 68.3 in FY 1983, a non-significant increase (Mann-Whitney U-Test, U=72 $P > 0.20$; Sokal and Rohlf 1981) and the larges number of deer seen on any monhtly count increased from 90 in FY 1982 to 100 in FY 1983 (Table 6). The 1983 increase in the AAFB deer herd appears to be a continuation of the general increasing trend observed over the past 5 years (AWRD 1979-1983) and a reversal of the decrease that occurred during the late 1970's (Wheeler 1979). The population showed a slight increase in spite of the 21 deer harvest (13 M, 8 F) during the "special" either-sex control hunt in December 1982.

The average number of deer seen per count at NAVMAG decreased again for the second year in a row, however, the largest number of deer seen on any monthly count increased over FY 1982 (AWRD 1981-1982). The average deer count decreased from 19.4 in FY 1982 to 16.9 in FY 1983, a non-significant decrease (Mann- Whitney U-Test, U=87, $P > 0.20$) and the maximum count increased from 31 in FY 1982 to 36 in FY 1983 (Table 6). The NAVMAG herd apparently is continuing the gradual decline which started in the early 1970's (Wheeler, 1979).

A spotlight count was tried at NWF in March between the hours of 7 and 10 p.m. No deer were observed in over 32 Km of spotlighting. However, stationary counts of 10-15 minutes duration (at strategic locations on the runways) early in the morning produced observations of up to 14 deer crossing the runways. These observations combined with the annual deer harvest on NWF indicate that the deer on NWF are not readily observed during night spotlight counts. Evidently the deer have learned to avoid spotlighters from their exposure to spotlight poaching.

Feral Asiatic Water Buffalo

Water buffalo (Carabao) were counted on the monthly deer spotlight counts at NAVMAG. The average number of carabao seen per count decreased from 58.2 in FY 1982 to 43.7 in FY 1983 (Table 5), a significant decrease in carabao numbers (Mann-Whitney U-Test, U=104.5, $P < 0.10$). However, the maximum count increased from 76 in FY 1982 to 83 in FY 1983.

Table 3. Hunter effort and deer take based on official hunter logs from NAVCAMS, NWF, and the AAFB "special hunt".

	NAVCAMS		NWF				AAFB Special Hunt			
	No. hunter sorties	Deer take	No. gun sorties	No. bow sorties	Deer take		No. gun sorties	No. bow sorties	Deer take	
					Gun	Bow			Gun	Bow
October	432	1	382	40	9	-				
November	274	0	198	11	2		45	7	3	-
December	395	1	175	18	4		166	10	18	
Total	1101	2	824		15		228		21	
Total hunter days	573.5		554				98			
Hunter days spent per deer taken	286.7		36.9				4.7			

Table 4. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, FY 1983.

	1981			1982										AVE. NO.	ST.	
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	COUNT	DEVIATION	C.V.
Unclassed Buck	2	5	3	2	1	2	1	1	1	1	2	4	25			
Spike	2	2		2		1	1		1		2		11			
2 PT	2	6	2		1	6			2	1	2	1	23	10.8	6.31	58.4%
3 PT	7	11	3	4	4	6	4	3	4	5	13	4	68			
4 PT		1	1								1		3			
Doe	35	35	25	29	22	36	22	12	36	46	46	43	387	32.3	10.53	32.6%
Yearling		1	1	4	3	4	1	2	7	5	7	2	37	3.1	2.35	75.8%
Fawn			3	3	2	2		3	1	4	6	4	28	2.3	1.87	73.9%
Unclassed Deer	18	16	17	24	11	16	29	9	29	31	21	16	237	19.7	7.15	36.3%
TOTAL	66	77	55	68	44	73	58	30	81	93	100	74	819	68.3	19.66	28.8%
Km Traveled	10.8	10.5	7.4	10.0	10.3	10.1	10.0	10.6	10.9	10.9	10.0	9.8	121.3	10.1	0.94	9.3%
Deer / 10 Km	61.2	73.6	74.3	68.0	42.7	72.0	58.0	28.2	74.0	84.9	100.0	75.3	812.2	67.7	18.72	27.7%
Deer / 10 Miles	98.5	118.5	119.6	109.5	68.7	115.9	93.4	45.5	119.1	136.8	161.0	121.3	1307.8	109.0	30.14	27.7%

Table 5. Composition of deer herd and number of water buffalo seen during spotlight counts at Naval Magazine, FY 1983.

		1981						1982								
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	AVE. NO. COUNT	ST. DEVIATION	C.V.
Unclassed Buck	1		2		3			1	2		1		10	2.9	2.02	69.7%
Spike		2			2						1	1	6			
2 PT	1	1			1		1	2	2				8			
3 PT	1	2	1	1			2	1	2	1			11			
4 PT													0			
Doe	7	16	3	3	9	7	3	12	7	14	3	2	86	7.2	4.75	66.0%
Yearling	1	3	1		2	1		1	4	1			14	1.2	1.27	105.8%
Fawn		5			1	1		1					8	0.7	1.44	205.7%
Unclassed Deer	1	7	7	9	7	4	1	3	4	9	5	3	60	5.0	2.80	56.0%
TOTAL	12	36	14	13	25	13	7	21	21	25	10	6	203	16.9	8.83	52.2%
Km Traveled	22.1	22.2	21.6	22.2	22.4	22.9	22.2	22.7	22.9	23.0	23.2	21.6	269	22.4	0.53	2.4%
Deer / 10 Km	5.4	16.2	6.5	5.9	11.2	5.7	3.2	9.3	9.2	10.9	4.3	2.8	90.6	7.5	3.92	52.3%
Deer / 10 Miles	8.8	26.1	10.4	9.4	18.0	9.2	5.1	14.9	14.8	17.5	6.9	4.5	145.6	12.1	6.31	52.1%
Water Buffalo	40	60	83	17	19	45	47	63	20	49	24	57	524	43.7	20.64	47.2%

Table 6. Summary of deer and water buffalo spotlight counts at Andersen Air Force Base (AAFB) and Naval Magazine (NAVMAG) for FY 1982 and 1983.

	Deer				Water Buffalo	
	AAFB		NAVMAG		NAVMAG	
	FY82	FY83	FY82	FY83	FY82	FY83
No. Counts	12	12	12	12	12	12
Maximum Count	90	100	31	36	76	83
Mean/Count	66.4	68.3	19.4	16.9	58.2	43.7
Significance test and probability	NSD $P > 0.20$		NSD $P > 0.20$		SD $P < 0.10$	

RECOMMENDATIONS

Increase the number of spotlight counts on AAFB and initiate counts at NWF. Collect biological data from carcasses killed during the AAFB special hunts. Obtain a better response rate from hunter reports.

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Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs

PERIOD COVERED: October 1, 1982 to September 30, 1983

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 21 if adequate manpower is available.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT: W-1
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam

PERIOD COVERED: October 1, 1982 to September 30, 1983.

SUMMARY

Despite a 30% increase in license sales, the estimated number of pig hunters in FY 1983 remained at the 1982 level of 266. The estimated total legal pig take increased to 452 whereas the total number of days spent hunting pigs decreased to 1623 and the effort expended per pig taken dropped to 3.6 days a field per pig taken. The military installations of Northwest Field (NWF) and Naval Communications Area Master Station (NAVCAMS) remained the most popular areas to hunt on island with Bolanos and Anao reported as the most popular Territorial Conservation Reserves.

BACKGROUND

The wild pig (Sus scrofa) is one of Guam's two game mammals. The wild pigs on Guam descend from stock introduced by the Spanish during their 300-year role on the island. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam.

Fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint.

OBJECTIVES

To determine current population size and distribution and to monitor trends.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.

2. Conduct surveys using sign counts, flushing counts, or other methods,to determine the relative abundance of pigs in the Bolanos Conservation Area.

3. Monitor the harvest of pigs during the legal hunting season.

RESULTS

Pig Hunting Statistics

The legal season for pigs in FY 1983 ran from October through December with a daily limit of 1 pig and a season limit of 10 pigs. A total of 467 licenses was sold in FY 1983 and 102 license buyers (21.8%) returned their hunter report cards or responded to a follow up questionnaire on their hunting activity. Of the 102 respondents, 79 (77.5%) reported they actively hunted during FY 1983 yielding an estimated number of 362 legal hunters (Table 1) during the season.

Of the 79 responding hunters, 58 (73.4%) reported they had hunted pigs during FY 1983. Sixty-five percent of the reporting hunters successfully took pigs during the season killing an average of 2.6 pigs each. Fifty hunters provided information on the hours they hunted pigs and reported they spent an average of 6.1 days hunting each. Overall, pig hunting in FY 1983 was moderately better than in FY 1982. Hunter success increased from 56.3 to 65.5% and the amount of hunting effort expended per pig harvested decreased from 6.0 to 3.6 days of hunting per pig taken (AWRD 1982).

Estimates of total harvest and hunter effort were derived from the hunter questionnaires returned by the hunters. An estimated 266 legal pig hunters spent 1623 days hunting pigs and harvested 452 pigs. The estimated harvest for FY 1983 increased 16% over FY 1982 while the total hunting effort decreased by 31%.

The most popular areas to hunt pigs remained the NWF and NAVCAMS military installations, with 38% and 36% respectively, of pig hunters reporting they hunted those areas (Table 2). The Bolanos and Anao Conservation Areas were reported as the most popular territorial reserves in which to hunt pigs with 14% and 7%, respectively, of reporting pig hunters hunting there. Military lands received the heaviest pig hunting pressure with an estimated 534 hunter days spent hunting pigs on NWF and 424 hunter days on NAVCAMS. Of non-military lands, Cotal Conservation Area (Tarzan Falls) received an estimated 90 hunters days of hunting pressure and private property received 30 hunter days. Hunting the Bolanos area was the most fruitful in regards to the hunting effort spent per pig taken. Only a half days effort was expended for every pig taken in the Bolanos area, whereas on the military bases, 4 to 5 days were spent hunting for every pig taken (Table 2).

A record of the hunting activity and harvest was kept on the NWF, NAVCAMS and AAFB military installations. Persons hunting on these bases were required to record the number of hours spent hunting and the game harvested in an official hunter log. The information compile from the official hunter logs is summarized in Table 3 and provides an accurate record of hunting activity for these areas against which the estimated kill, as derived form the hunter reports (Table 2), can be evaluated. The hunter report derived estimated kill was 4.8 times the official record at NAVCAMS and 2.1 times the official record at NWF, indicating that the

Table 1. Island-wide pig hunting statistics for FY 1983.

a.	Total license sales for all game species	467
b.	Number of hunter reports/questionnaires returned	102
c.	Percent of license buyers reporting	21.8%
d.	Number of reporting license buyers (102) that hunted any species	79
e.	Percent of license buyers that hunted any species	77.5%
f.	Estimated total number of legal hunters (axe)	362
g.	Number of reporting hunters (79) that hunted pigs	58
h.	Percent of reporting hunters that hunted pigs	73.4%
i.	Number of successful pig hunters	38
j.	Percent of reporting pig hunters that took pigs (i ÷ g x 100)	65.5%
k.	Number of pigs taken by 58 pig hunters	98
l.	Average number of pigs taken per pig hunter (k ÷ g)	1.7
m.	Average number of pigs taken per successful pig hunter (k ÷ i)	2.6
n.	Estimated total number of legal pig hunters (fxh)	266
o.	Estimated total legal pig take (nxl)	452
p.	Number of 8-hour days expended by 50 reporting pig hunters	307
q.	Average number of 8-hour days spent hunting per 50 reporting pig hunters	6.1
r.	Estimated total number of days spent pig hunting (nxq)	1623
s.	Number of 8-hour days spent hunting per pig taken (r ÷ o)	3.6

Table 2. Pig hunting statistics broken down by popular hunting areas based upon hunter reports and questionnaires returned by 58 pig hunters for FY 1983.

Area	No. hunters	% Pig hunters	No. days hunting	Pigs taken	% Hunter success	Ave. take	Estimated total days hunting	Estimated kill	Estimated effort/pig taken (days/pig)
NWF	22	37.9	116	26	63.6	1.2	534	121	4.4
NAVCAMS	21	36.2	93	20	42.9	1.0	424	96	4.4
Bolanos	8	13.8	8	16	75.0	2.0	37	73	0.5
AAFB	7	12.1	11	2	28.6	0.3	51	10	5.1
Anao	4	6.9	5	4	75.0	1.0	24	18	1.3
Tarzan Falls	2	3.4	20	5	50.0	2.5	90	23	3.9
Dandan	1	1.7	13	3	100.0	3.0	59	14	4.2
Private	10	17.2	67	22	70.0	2.2	307	101	3.0

Table 3. Hunter effort and pig take based on official hunter logs from NAVCAMS and NWF.

	NAVCAMS		NWF			
	No. hunter sorties	Pig take	No. gun sorties	No. bow sorties	Pig take	
					Gun	Bow
October	432	17	382	40	32	-
November	274	2	198	11	17	-
December	395	1	175	18	8	
Total	1101	20	824		57	
Total hunter days	573.5		554			
Hunter days spent per pig taken	28.7		9.72			

hunter report card derived figures greatly over-estimate the actual take. The inflated hunter report kill figures can probably be traced to the fact that successful hunters report their hunting history more readily than unsuccessful hunters. Consequently, the responses of successful hunters are over represented in the survey of hunter activities.

RECOMMENDATIONS

Continue to monitor the annual pig harvest and collect biological information and samples from the hunter killed animals. Distribute hunter questionnaires at the close of the pig season to improve the hunter response to the questionnaire.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1982. Job Progress Report - Federal Aid to Fish and Wildlife Restoration, Guam Dept. of Agriculture.

Report prepared by Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Philippine Turtle Doves

PERIOD COVERED: October 1, 1982 to September 30, 1983

OBJECTIVES

To prepare a status report on Philippine turtle doves for use in planning future work.

RESULTS

This job was inactive during this segment due to the shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 21 if adequate manpower is available.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-20
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Hunter participation increased for both the 1982 and 1983 Philippine Turtle Dove seasons. The estimated dove take decreased in 1982 to 270 birds then increased slightly in 1983 to 291 birds. Hunting effort increased in 1982 and 1983 to 115 and 249 hunter days respectively, however take per effort declined from over 5 doves per day in 1981 to 2.35 and 1.17 doves per day in 1982 and 1983. The Northwest Field (NWF), Naval Communications Area Master Station (NAVCAMS) and private lands were the most popular areas to hunt on the island. Roadside count and stationary count data indicated that Philippine Turtle Dove numbers continued to decline in northern Guam but may have increased slightly in southern Guam.

BACKGROUND

Until recently, the Philippine Turtle Dove (Streptopelia bitorquata) was the only game bird on Guam. It was introduced by the Spanish about 1771 from the Philippines (Baker, 1951). The Philippine Turtle Dove has been a regulated game bird since the first hunting season was established in 1965. The FY 1982 hunting season was July 1 to July 31, with a daily limit of four birds and a season limit of twenty, whereas in FY 1983 the season length and season limit remained the same but the daily limit was increased to 5 birds. Although considerable work has been done in the past on nesting and movement of Philippine Turtles Doves (Drahos, 1977) current effort is restricted to population counts and monitoring of hunter harvest.

OBJECTIVE

To determine present population levels and distribution and monitor harvest and population trends.

PROCEDURES

Pre- and post dove season call count surveys and roadside counts were conducted at NWF and the Conventional Weapons Storage Area (CWA) on Andersen Air Force Base (AAFB). Both surveys were conducted in early

morning. The call count survey consist of counting the number and species of doves seen or heard during a 5 minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside count at CWA involved counting the number of Philippine Turtle Doves seen while driving at 25 km per hour along an established 32 km route. The Philippine Turtle Dove is also censused in a bi-weekly roadside count survey conducted in 3 areas of northern Guam (Job W-1-3) and in an annual or monthly forest bird survey (Job W-11-1-3) conducted in 4 areas of northern Guam. The annual hunter harvest during the legal season was monitored at hunter checking stations and by a hunter report card returned at the end of the hunting season or by a direct mail questionnaire. Information from the hunter questionnaires was used to estimate the number of Philippine Turtle Doves harvested during the season.

RESULTS

Dove Hunting Statistics

The legal dove season for 1982 and 1983 was July 1 to July 31 with a daily limit of 4 birds in 1982 and 5 birds in 1983 and a season limit of 20 birds for both years. The hunting statistics for 1982 and 1983 are summarized in Table 1. The number of legal dove hunters increased from 33 in 1981 to 50 in 1982 and to 53 in 1983. Hunter success increased from 54.5% in 1982 to 74.1% in 1983. However, the average number of doves taken per successful hunter decreased from 9.8 in 1982 to 7.4 in 1983 and only 7 daily bag limits were reported taken in 1983. The total estimated legal take increased slightly from 270 in 1982 to 291 in 1983 but remained considerably below the 1980 level of 684 and the 1981 level of 340 birds. Hunting effort increased from 115 days spent dove hunting in 1982 to 249 days in 1983 and the number of doves taken per hunter day decreased from 2.35 in 1982 to 1.17 in 1983. The figures for hunting effort in FY 1983 may not be directly comparable to earlier years however, as the hunters reported number of days (or partial days) spent hunting rather than hours hunting as in FY 1982 and earlier.

The NWF and NAVCAMS military bases and private property were the most popular places to hunt doves in both 1982 and 1983 (Table 2) with the Tarzan, Anao, and Bolanos conservation reserves and the Dandan area also hunted in 1983. The military bases received heavy hunting pressure in both fiscal years as did private property. The high estimated kill figures and hunting pressure on private property in 1982 (Table 2) are probably gross over-estimates and a peculiarity of the small sample size (low report card return rate) and the fact that successful hunters are most likely to return their cards. The reported hunting areas, kill estimates, and hunting efforts for 1983 are probably more accurate as they were based on the responses of over half the legal dove hunters.

A record of the hunting activity and harvest was kept on the NWF and NAVCAMS military bases. Persons hunting on these bases were required to record the number of hours spent hunting and the game harvested in an official hunter log. The information compiled from the hunter logs is summarized in Table 3. The estimated take from hunter reports for NWF was 145% of the harvest recorded in the official log, whereas the estimated take at NAVCAMS was well below (17%) the harvest recorded in the official

Table 1. Island-wide Philippine Turtle Dove hunting statistics, July 1982 and 1983. Values cited in the text for fiscal year 1983 are enclosed in [ ].

		July 1982	July 1983
a.	License sales.	467	93
b.	Number of hunter reports/questionnaires returned.	102	47
c.	Percent of license buyers reporting.	21.8%	50.5%
d.	Number of reporting license buyers that hunted any species.	79	32
e.	Percent license buyers that hunted.	77.5%	68.1%
f.	Estimated total number of legal hunters.	362	63
g.	Number of reporting hunters (d) that hunted doves.	11	27
h.	Percent of reporting hunters that hunted doves (g ÷ d x 100).	13.9%	84.4%
i.	Number of successful dove hunters.	6	20
j.	Percent of reporting dove hunters that took doves (i ÷ g x 100).	54.5%	74.1%
k.	Number of doves taken by (g) dove hunters.	59	148
l.	Average number of doves taken per hunter (K ÷ g).	5.4	5.5
m.	Average number of doves taken per successful dove hunter (K ÷ i).	9.8	7.4
n.	Estimated total number of legal dove hunters (fxh).	50	53
o.	Estimated total legal dove take (mxl).	270	291
p.	Number of 8-hour days expended by 10 [27] reporting dove hunters.	23.4	127
q.	Average number of 8-hour days spent hunting per 10 [27] reporting dove hunters.	2.3	4.7
r.	Estimated total number of days spent hunting doves (mxq).	115	249
s.	Number of 8-hour days spent hunting per dove taken (r ÷ 0).	0.43	0.86
t.	Number of doves taken per day (0 ÷ r).	2.35	1.17
u.	Number of daily limits shot during season.	ND	7

Table 2. Philippine Turtle Dove hunting statistics broken down by popular hunting areas based upon hunter reports and questionnaires returned by 11 hunters in FY 1982 and 27 hunters in FY 1983.

Area	No. hunters	% dove hunters	No. days hunting	Doves taken	% hunters successful	Ave. take	Estimated kill	Total days hunting	Estimat take/eff (doves/d
FY 1982									
NWF	4	36	9.3	24	75	6.0	108	42	2.57
NCS	5	45	6.6	0	0	0	0	30	-
Private	3	27	11.3	35	100	11.7	158	51	3.10
FY 1983									
NWF	16	59	73	120	87.5	7.5	235	144	1.63
NCS	4	15	15	2	50	0.5	4	30	0.13
Dandan	2	7	11	0	0	0	0	20	-
Tarazan	1	4	6	2	100	2	4	13	0.31
Anao	1	4	2	2	100	2	4	4	1.0
Bolanos	1	4	3	0	100	0	0	6	-
Private	5	19	17	22	60	4.4	44	34	1.29

Table 3. Hunter effort and dove harvest based on official hunter logs from NAVCAMS and NWF for Fiscal Year 1982 and 1983.

Area	No. hunter sorties	Total hunter days	Doves taken	No. daily limits	Take/effort (doves/day)
FY 1982					
NAVCAMS	24	12	8	0	0.67
FY 1983					
NAVCAMS	43	22	23	0	1.05
NWF	114	85	162	6	1.91

Table 4. Age and sex of Philippine Turtle Doves examined at the Northwest Field hunter check station during the July, 1983 bird season.

AREA	Male		Female	
	Juvenile	Adult	Juvenile	Adult
Northwest Field	5	23	1	21
TOTALS	28		22	

log. The inconsistent trend in hunter response, an over-estimate of the harvest at NWF versus an under-estimate at NAVCAMS, can probably be attributed to the situation that more successful hunters reported from NWF than unsuccessful hunters and that few of the hunters from NAVCAMS responded to the questionnaire.

A hunter check station was manned at NWF during the first 3 weekends of the season. Hunters voluntarily provided carcasses (the hunters retained the meat) for further biological study. Fifty carcasses were examined and classified as to age and sex (Table 4). The overall sex ratio was slightly skewd toward males, 127:100 males to females, but the adult sex ratio was more even, 109:100 adult males to adult females. The age ratio of juveniles to adults was 14:100 and the ratio of juveniles to 100 adult females to adult males was 29:100:109.

Population Surveys

Call count surveys and roadside counts were initiated in FY 1983 in the NWF and the Conventional Weapons Storage Area on Andersen Air Force Base. The results of those surveys are presented in Table 5. As expected, both counts declined after the July dove season when 162 birds were harvested from the NWF area. Surveys will be continued in FY 1984 to determine if the dove population recovers to the 1983 pre-harvest level.

Roadside counts in FY 1983 recorded a continued decline in Philippine Turtle Dove numbers on the Northwest Field and North-Central route over FY 1982 levels, but a slight increase on the Northern route (Tables 1-4 of Job W-4-1-3 report).

The long term trend in Philippine Turtle Dove numbers is presented in Figure 1 and graphically illustrates the decline in dove numbers in recent years for all 3 areas. A decreasing trend in Philippine Turtle Dove numbers was also recorded on variable-circular plot transects in 3 areas of northern Guam (Table 5 of Job W-4-1-3 report). However, incidental citings of Philippine Turtle Doves during Black Francolin counts more than doubled in some areas of Southern Guam from 1982 to 1983 (Table 7 of Job W-4-1-3 report).

RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of Philippine Turtle Dove.

2. Continue to monitor hunter harvest and adjust hunting seasons and bag limits to provide for sustained yield management of dove populations.

3. Collect information on age and sex ratios, molt, and food habits from hunter harvested birds.

4. Initiate a banding program at NWF prior to the July 1984 dove season so as to obtain a population estimate from bands returned in the hunters bag.

ble 5. Number of birds observed on Northwest Field call count surveys and Andersen Air Force Base roadside counts in FY 1983. The annual Philippine Turtle Dove hunting season was in July.

11 Count Survey: Northwest Field

Month	April		May				June		July	Aug			X/Count
Day	12	13	5	12	21	24	2	30	15	11	17	31	
ilippine Turtle Dove	54	63	48	50	48	83	51	82	67	55	51	53	57.1
ratio V/A[1]	2.2	0.8	1.7	3.6	8.8	10.9	5.4	4.9	2.9	1.5	0.8	1.7	3.8
ite Throated Ground Dove	6	12	2	4	3	0	4	0	2	1	4	0	3.2
uit Dove	8	15	3	4	1	5	7	6	1	5	3	2	5.0

adside Count Survey: Anderson Air Force Base

Month	June		July	August	September	X/Count
Day	4	31	5	30	13	
ilippine Turtle Dove	211	155	44	55	68	106.6

atio of the number of visual observations to audio observations. This figure provides a ough measure of the number of birds feeding or loafing in the open to the number of birds alling from forested areas. For example, visual sightings declined in August in relation to he number of audio observations coinciding with an increase in breeding activity during that eriod.

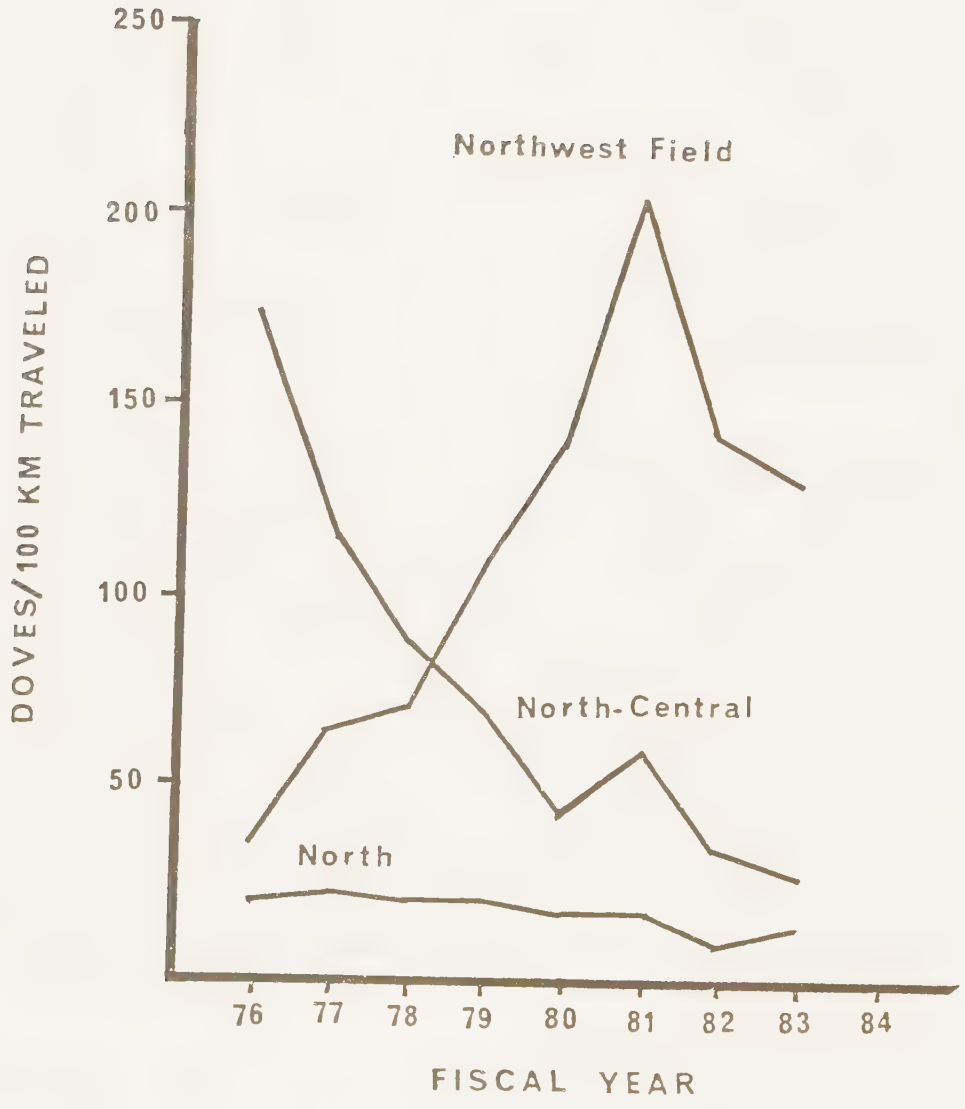

Figure 1. Population trend of Philippine Turtle Dove for three areas of Northern Guam.

LITERATURE CITED

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Drahos, N. 1977. The Doves of Guam. Unpublished manuscript. Division of Aquatic and Wildlife Resources.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Regulations were promulgated to establish a Black Francolin hunting season during the months of January and July with a daily bag limit of 5 birds and no season limit. Ninety-three licenses were sold for the July 1983 bird season and an estimated 35 legal hunters hunted Black Francolin and took an estimated 116 birds. The Dandan area was the most popular area to hunt francolin on the island with the Tarzan and Bolanos areas also hunted. Call count surveys continued in the Pulantat, Talofofo, and Merizo areas of southern Guam and an additional route was added in the Dandan area. The annual mean male calling activity more than doubled (significant increase) on the Pulantat and Talofofo survey routes over the FY 1982 levels indicating the francolin population is continuing to expand rapidly. No evidence of disease was found in francolin carcasses examined to date.

BACKGROUND

In 1961, 171 Black Francolin (Francolinus francolinus) were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4 bird daily limit and a 20 bird season limit. Francolin populations continued to increase from 1980-1982 but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY 1983 to a 2 month-split season, 1 month in January and 1 month in July, with the bag limit increased to 5 bird per day, no season limit. The Division arranged a special hunt in the Dandan area in southern Guam during the last 2 weekends of July 1983 to obtain carcasses for disease sampling and biological data. A number of hunters participated and successfully harvested birds. No evidence of disease was found in the specimens examined to date.

OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct monthly call count surveys in areas of savannah habitat.
2. Conduct pre and post hunt call count surveys in the Dandan area.
3. Monitor hunter harvest and collect data on harvested birds.
    a. Collect information on hunter effort and take at hunter check station.
    b. Collect data on age ratios, sex ratios, reproductive status, and food habits of harvested birds.
    c. Compile and analyze information on francolin hunting statistics from a hunter questionnaire distributed after the season.

RESULTS

Francolin Hunting Statistics

The legal season and bag limits for Black Francolin were liberalized in FY 1983 (June) to a 2-month-split season, 1-month in January and 1-month in July, with the bag limits increased to 5 birds per day and no season limit. The season was also moved from December to January so as not to coincide with the deer season. Consequently, the francolin season in FY 1983 was open for 1 month in December 1982 and 1 month in July 1983. Whereas next fiscal year, the season will be open in January and July as established in the hunting regulations adopted in June 1983.

The December 1982 francolin season did not draw the participation that was expected. There were 467 licenses sold for the 1982 general hunting season and an estimated 362 persons actively hunted. One hundred-two license buyers reported on their hunting activities of which 79 reported they actively hunted. Of the 79 responding hunters, none reported they had hunted Black Francolin in December 1982. Apparently, few if any of the island's sportsmen hunted Black Francolin in December 1982. The probable reason for the lack of interest in hunting francolin could be that most hunters were unfamiliar with the sporting qualities of the bird or they chose to hunt deer or pigs in the north during the concurrent season.

The July 1983 Black Francolin season was the first season to receive an appreciable amount of hunter participation. Ninety-three licenses were sold for the July Philippine Turtle Dove and Black Francolin seasons and after the season a questionnaire was mailed to all license buyers. Forty-seven

questionnaires were returned (50.5%), and of these, 32 (68.1%) responded that they had actively hunted birds. Based on that proportion, an estimated 63 legal bird hunters participated in the July season.

Of the 32 responding bird hunters, 18 (56.3%) reported they had hunted Black Francolin during the season (Table 1). Sixty-seven percent of the francolin hunters successfully took birds during the season, killing an average of 5.0 birds each. The 18 hunters that provided information on the effort expended hunting francolin reported they spent 67 hunter days in the field with an average of 3.7 days per hunter (where a hunter day is all or any part of a day spent in the field). No one reported shooting a daily limit of 5 birds.

Estimates of hunter participation, total harvest, and hunter effort derived from hunter questionnaires indicated that 35 hunters legally hunted Black Francolin during the July season. The 35 hunters spent 130 days in the field and harvested 116 birds, 1.12 days spent hunting per bird taken.

Table 1. Island-wide Black Francolin (BLFR) hunt statistics for July, 1983.

a.	License sales (as of July 31, 1983)	93
b.	Number of hunter questionnaires returned	47
c.	Percent of license buyers reporting	50.5%
d.	Number of reporting license buyers that hunted during the July bird season	32
e.	Percent license buyers that hunted	68.1%
f.	Estimated total number of legal bird hunters	63
g.	Number of reporting hunters (d) that hunted Black francolin	18
h.	Percent of reporting hunters that hunted BLFR	56.3%
i.	Estimated total number of legal BLFR hunters (fxh)	35
j.	Number of successful BLFR hunters	12
k.	Percent of hunters that were successful (j ÷ g x 100)	66.7%
l.	Number of BLFR taken by 18 reporting hunters	60
m.	Average number of BLFR taken per hunter (l ÷ g)	3.3
n.	Average number of BLFR taken per successful hunter (l ÷ j)	5.0
o.	Estimated total legal BLFR take (ixm)	116
p.	Number of days hunting expended by 18 reporting BLFR hunters	67
q.	Average number of days spent hunting per reporting BLFR hunter	3.7
r.	Estimated total number of days spent hunting BLFR (qxi)	130
s.	Number of days spent hunting per BLFR taken (r ÷ o)	1.12
t.	Number of BLFR taken per day hunting (o ÷ r)	0.89
u.	Number of daily limits shot during season	0

Dandan was by far the most popular area to hunt on island with 83% of francolin hunters hunting there. Francolin hunters spent an estimated 102 days in the field in Dandan and harvested an estimated 102 birds (Table 2). Other areas hunted for francolin included the Tarzan Falls and Bolanos conservation areas, hunted by 11% and 6% of the reporting hunters an estimated 22 and 6 days with estimated harvests of 14 and 0 birds, respectively.

Birds harvested by hunters in the Dandan area or collected by Division biologists were classified by sex and age (Table 3). Classification as to either a juvenile or adult age class was based on the presence or absence of the bursa of fabricius. Fifty-four birds were examined and classified. Nearly twice (184%) as many males were harvested or collected as females and an equal amount of juveniles as adults were taken. The higher harvest of males can be attributed to the more visible behavior of the male versus the secretive behavior of the female. Only males call to attract mates and defend territories and the easiest and most productive way to hunt francolin is to home-in on calling males. Consequently, males are more susceptible to hunting mortality and are probably over-represented in the bag as to their true proportion in the population with females under-represented.

Likewise, just as females were under-represented in the hunters bag so too were juvenile age class birds. The harvested age ratio of 1-juvenile to 1-adult probably under represented the true proportion of juveniles in the population. However, the harvested sex and age ratio of 250 adult males to 100 adult females to 367 juveniles (250:/100:/367) harvested during the July hunting season was ideal in regards to the management goals for the sex and age composition of the harvest. An annual harvest of more adult males and juveniles than adult females combined with the promiscuous-polygynous mating behavior of the male should have the least effect on the reproductive capacity of the population. Such a harvest strategy should provide for recreational hunting and a sustained yield of francolin in the future.

Call Count Surveys

Monthly call count surveys continued in the Pulantat, Talofofo, and Merizo areas of southern Guam with a fourth survey added in the Dandan area (Fig. 1). It is assumed that the number of calling males counted per survey provided an accurate index by which to assess population trend. If so, FY 1983 counts indicated that the francolin population increased in all areas. The mean number of calling male Black Francolin increased significantly in the Pulantat area (Mann-Whitney U Test, $U = 82$, $P < 0.01$; Sokal and Rohlf 1981) and the Talofofo area (Mann-Whitney U Test, $U = 105$, $P < 0.001$) and non-significantly in the Merizo area (Mann-Whitney U Test, $U = 48.5$, $P > 0.20$), with increases of 113%, 113% and 24% respectively over the FY 1982 counts (Table 4).

Table 2. Black Francolin (BLFR) hunting statistics broken down by popular hunting areas based upon hunter questionnaires returned by 18 BLFR hunters.

Area	No. hunters	% BLFR hunters	No. days hunting	BLFR taken	% hunter success	Ave. take	Estimated kill	Estimated total days hunting	Estimated effort/BLFR taken (days/bird)
Dandan	15	83.3	53	53	66.7	3.5	102	102	1.0
Tarzan	2	11.5	11	7	100	3.5	14	22	1.57
Bolanos	1	5.6	3	0	0	0	0	6	-

Table 3. Age and sex of Black Francolin examined at hunter check stations or collected by Division biologists.

MONTH	AREA	Male		Female	
		Juvenile	Adult	Juvenile	Adult
April	Bubulao		2		2
May	Bubulao		2	2	
July	Dandan	13	15	9	6
August	Dandan	3			
Subtotals		16	19	11	8
Totals		35		19	

Table 4. Summary of Black Francolin call count surveys for FY 1982 and 1983 in 3 areas of southern Guam.

	Pulantat		Talofofo		Merizo	
	FY 82	FY 83	FY 82	FY 83	FY 82	FY 83
. counts	11	8	11	10	12	7
nual x calling ales per station	2.31	4.91	2.29	4.88	1.36	1.69
ghest monthly ount	3.0	5.9	3.47	5.7	2.0	3.0
gnificance test nd probability	SD P < 0.01		SD P < 0.01		NSD P > 0.20	

Figure 1. Black Francolin transect routes in southern Guam.

Calling activity varied from area to area and month to month on the island. The peak in calling activity occurred in the month of May in Pulantat and Talofofo, August in Dandan, and November in Merizo (Table 5). Calling activity varied considerably even within a single month as in Dandan where multiple monthly surveys were conducted.

Using calling activity to assess relative densities, it appears that the Dandan area has one of the largest populations on island. The Dandan area had the highest annual mean and highest single monthly count of the four areas surveyed (Table 5). The Talofofo and Pulantat areas had comparable annual means whereas the Merizo area had the lowest annual mean of the areas surveyed.

The July hunt in the Dandan area did not appear to effect the population to any great extent. High numbers were counted both before and after the hunt with the highest count occurring after the hunt. With population increases of over 100% for some areas of Guam, it is evident that the francolin population is indeed well established and can withstand much heavier hunting pressure.

RECOMMENDATIONS

1. Continue monthly surveys of Black Francolin along 4 transect routes.

2. Collect and compile data on age and sex ratios, reproductive status and food habits of birds examined at hunter check stations throughout the 1984 Black Francolin hunting season.

3. Make an intensive pre and post hunting season survey of the Dandan transect to determine the effect of hunting.

4. Make quarterly collections of both sexes to collect data on reproductive status, age ratios, and food habits.

LITERATURE CITED

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman Company, San Francisco. 859p.

Report prepared by: Paul Conry

Table 5. Mean number of calling male Black Francolin per station recorded on surveys during FY 1983 in four areas of southern Guam. ND represents No Data.

	1982			1983									
Pulantat	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Annual $\bar{X}$
Day of month		30				31	22	18	28	18	25	29	
# Stations	ND	10	ND	ND	ND	8	10	15	15	15	15	10	
$\bar{X}$ Calling males per station		2.2				5.4	4.7	5.9	4.5	5.5	5.7	5.4	4.91
Talofofo													
Day of month	25		17		1	25		3	1 30	30	19	16	
# Stations	17	ND	17	ND	17	17	ND	17	17 17	15	17	17	
$\bar{X}$ Calling males per station	2.6		4.5		5.1	5.7		7.1	4.8 4.1	6.0	4.8	4.1	4.88
Dandan													
Day of month								26 31	3		12 18 24	20 23	
# Stations	ND	ND	ND	ND	ND	ND	ND	10 10	10	ND	10 10 10	10 10	
$\bar{X}$ Calling males per station								6.8 4.8	6.4		4.2 8.2 6.7	1.7 5.6	5.55
Merizo													
Day of month		20	24	29	26	19		21				24	
# Stations	ND	11	11	11	11	11	ND	11	ND	ND	ND	11	
$\bar{X}$ Calling males per station		3.0	1.5	2.4	1.0	0.8		2.3				0.8	1.69

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Survey and Inventory of Native Land Birds on Guam

PERIOD COVERED: October 1, 1982 to September 20, 1983

SUMMARY

Results of roadside counts and transect survey data indicated a continuing rapid decline of Guam's native forest birds. The Rufous-fronted Fantail and Bridled White-eye disappeared from the Ritidian basin and plateau area in 1983. The Guam Rail is now primarily restricted to two apparently discontinuous small populations located in extreme northern Guam at Northwest Field - Ritidian and Andersen Air Force Base areas.

BACKGROUND

The native forest bird populations have been declining since the mid-1960's. Factors which have been cited as possible causes of this decline are: predators, eg., the brown tree snake (Boiga irregularis), three species of rats (Rattus sp.) and the monitor lizard, (Varanus indicus), pesticides, loss of habitat, and disease. Native forest birds are now restricted primarily to the northern cliffline limestone forest and some species (the Bridled White-eye) are found only in the forested area east of Ritidian Point.

Roadside and variable circular-plot censuses have been invaluable in providing a quantitative means of showing the alarming precipitous decline of Guam's native forest birds. Roadside counts have been conducted since the early 1960's over 3 routes in central to northern Guam. Density estimates of native forest bird populations derived from variable-circular plot censuses were conducted from 1979 to 1981.

From June to July of 1981, an intensive forest bird survey utilizing variable-circular plots along randomly located transects was conducted by the U.S. Fish and Wildlife Service with the cooperation of this Division. A complete and detailed report is still pending. Certain areas have been resurveyed in subsequent years. In addition, the USFWS surveyed Rota, Tinian, Saipan, and Aguijan from March to June of 1982.

OBJECTIVES

To monitor population trends of the native land birds on Guam and the Northern Mariana Islands.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 6-9 Km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.

2. From February to June 1982, Division personnel surveyed of the original 23 variable circular plot transects established in June, 1981 (Figure 2). Prior to censusing, personnel received additional training in distance estimation and species identification ensure comparable data collection. The transects were randomly located to prevent bias and stations were premarked and placed 150m apart along the transects to minimize the possibility of observing the same bird from different stations. Stations were censused using eight minute variable circular-plot counts as described by Reynolds et. al. (1980).

RESULTS

Results of the roadside counts on the north, north central and Northwest Field routes are shown in Table 1, 2, and 3, respectively. The results are summarized and statistically compared with 1982 data in Table 4. Significant declines (P .05) in five species were detected in the north route. Two native species had declined in the north central route.

The north central route recorded significant increases in abundance of three species; the Marianas Crow (Miagra freycineti), Marianas Fruit Dove (Ptilinopus roseicapillus), and Guam Rail (Rallus owstoni). In addition, the Guam Broadbill (Miagra frecineti) was recorded along the north route for the first time in over 20 years.

Transect Surveys

The Species Incidence (total number of a species observed divided by the number of stations) of birds recorded in three areas over three years is shown in Table 5. Monthly counts of the Pajon Basin area are shown in Table 6. Of significance are the Guam Broadbill, Rufous-fronted Fantail (Rhipidura rufifrons uraniae), and Bridled White-eye (Zosterops c. conspicillata). These three species were reported as the more susceptible species to the present problem causing the decline (GAWR 1982). In the Pajon basin area, the Bridled White-eye population declined 97% in over three years. White-eyes were not recorded after May 1983. The Guam Broadbill declined 83 percent in the Ritidian basin area. Though the Fantail and White-eye were previously recorded in the Ritidian basin and plateau area, none were recorded in 1983.

Though most native species continued to decline over the past three years, the Marianas Crow, Micronesian Kingfisher (Halcyon c. cinnamomina) and Micronesian Starling (Aplonis opaca guami) remained constant or had increases in relative abundance over the past three years.

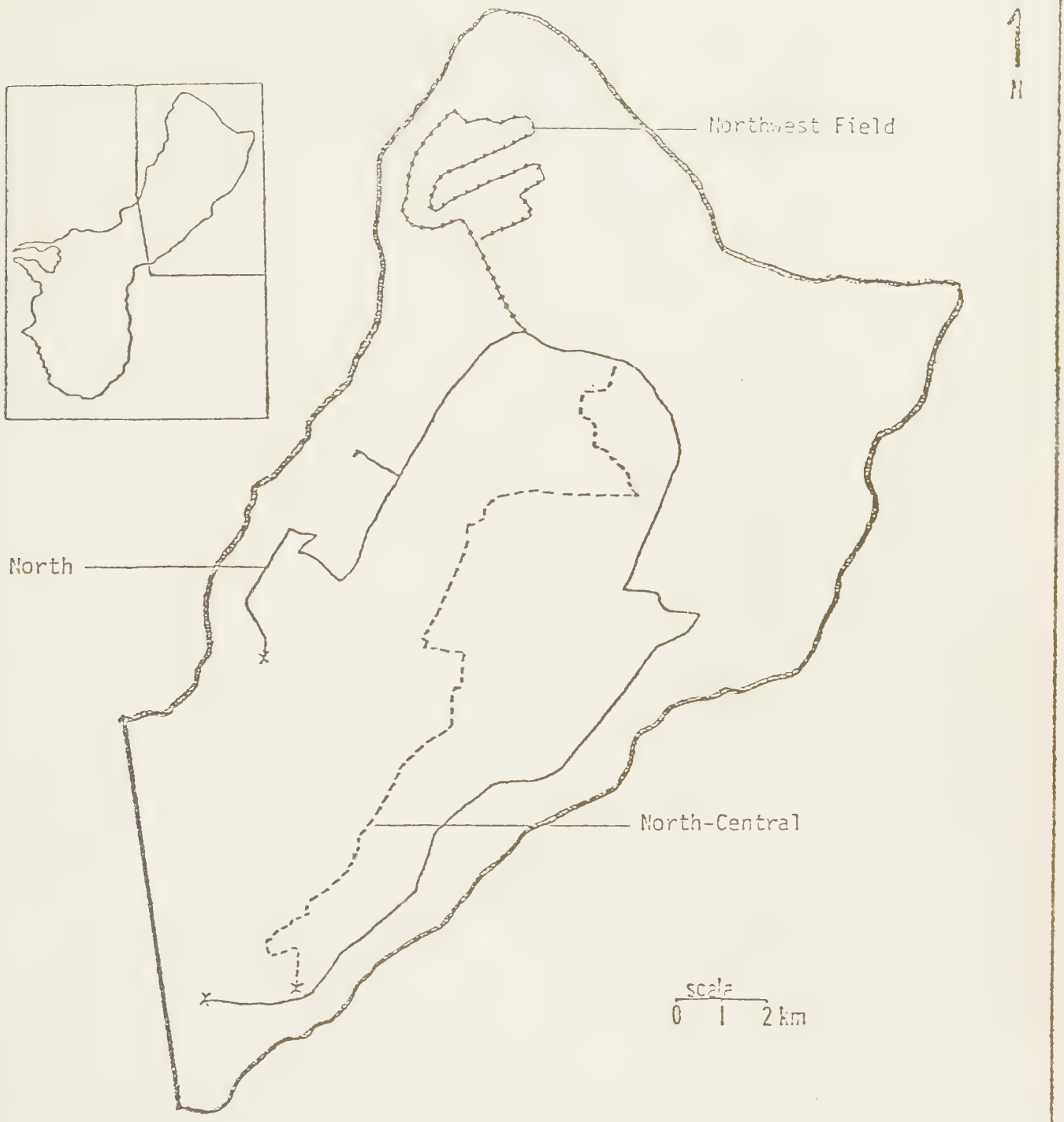

Figure 1. North, North-Central and Northwest Field roadside bird census routes along paved and unpaved roads.

Figure 2. Location of March 1984 survey route for the Guam Rail. The numbers correspond to the following areas: 1-Northwest Field, 2-Ritidian, 3-Andersen Conventional Weapons Area, 4-Andersen Air Force Base.

Table 1. Average number of birds per 100 Km observed each month on the North roadside count during Fiscal Year 1983.

Species	FY 1982 OCT	NOV	DEC	FY 1983 JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X COUNT	X/100 km
Yellow Bittern	1.3	3.6	2.6	1.3	3.2	5.1	7.7	0.0	10.3	0.0	0.0	0.0	19	1.1	2.9
Marianas Crow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Black Drongo	48.6	18.1	11.7	20.6	9.6	48.7	43.6	16.7	82.1	16.0	0.3	20.9	194	10.8	28.1
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Marianas Fruit Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Broadbill	0.0	0.0	0.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.0	2	0.1	1.0
Golden Plover	122.0	73.6	99.0	108.0	110.8	33.3	59.0	0.0	0.0	0.0	0.0	75.7	483	26.8	56.8
White-throated Ground Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Cardinal Honeyeater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Micronesian Kingfisher	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.1	0.2
Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Philippine Turtle Dove	9.2	12.1	18.2	14.1	12.8	12.8	2.6	1.3	33.3	8.0	8.0	18.3	87	4.8	12.6
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Chestnut Mannikin	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5	0.3	0.5
Eurasian Tree Sparrow	0.0	0.0	10.4	7.7	10.6	0.0	0.0	5.1	23.1	24.0	2.7	2.6	48	2.7	7.2
Micronesian Starling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
White Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Counts	2	2	2	2	2	1	1	2	1	1	1	1	18		

Table 2. Average number of birds per 100 Km observed each month on the North-Central roadside count during Fiscal Year 1983.

	FY 1982			FY 1983										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/COUNT	X/100 km
Yellow Bittern	9.9	2.5	5.3	0.0	16.7	5.3	2.5	5.1	7.8	5.1	7.5	0.0	25	1.1	5.6
Marianas Crow	14.8	0.0	0.0	9.6	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	16	0.7	3.3
Black Drongo	0.0	22.9	45.5	86.3	16.7	36.8	22.6	25.4	38.9	20.4	12.5	22.9	128	5.8	29.2
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Marianas Fruit Dove	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	0.2	0.8
Golden Plover	253.7	1175.6	1018.7	633.1	720.8	752.6	439.7	0.0	0.0	0.0	0.0	226.5	1919	87.2	435.1
White-throated Ground-Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Cardinal Honeyeater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Micronesian Kingfisher	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3	0.1	0.6
Noddy Tern	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	0.2	0.8
Philippine Turtle Dove	29.6	28.0	34.8	14.4	35.8	21.1	35.2	28.0	36.3	25.5	20.0	20.4	121	5.5	27.4
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Rail	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.1	0.4
Chestnut Mannikin	0.0	0.0	0.0	0.0	2.4	0.0	0.0	12.7	0.0	0.0	0.0	38.2	21	1.0	1.3
Eurasian Tree Sparrow	0.0	15.3	24.1	2.4	7.2	15.8	2.5	0.0	0.0	0.0	2.5	0.0	24	1.1	5.8
Micronesian Starling	0.0	0.0	0.0	7.2	14.3	0.0	0.0	2.5	15.5	0.0	0.0	0.0	21	1.0	3.3
White Tern	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.1	0.4
Counts	2	2	2	2	2	1	2	2	2	1	2	2	22		

Table 3. Average number of birds per 100 Km observed each month on the Northwest Field roadside count during Fiscal Year 1983.

	FY 1982			FY 1983											
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/Count	X/100 km
Yellow Bittern	8.0	37.7	23.1	0.0	2.9	5.8	3.0	16.0	0.0	11.7	11.1	2.9	42	2.0	10.2
Marianas Crow	66.8	34.8	57.8	24.4	23.0	46.8	11.9	34.8	37.4	105.0	58.2	49.9	181	8.6	45.9
Black Drongo	334.2	223.2	375.2	634.1	258.6	701.8	134.3	361.0	546.0	481.0	578.9	410.6	153.0	72.9	420.0
Rufous-fronted Fantail	37.4	0.0	14.5	36.6	11.5	29.2	0.0	2.7	14.4	11.7	0.0	17.6	50	2.4	14.6
Marianas Fruit Dove	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	1	.05	0.5
Golden Plover	125.7	87.0	40.5	0.0	103.4	0.0	0.0	0.0	0.0	0.0	0.0	11.7	131	6.2	30.7
White-throated Ground-Dove	2.7	2.9	0.0	0.0	0.0	5.8	3.0	2.7	5.7	5.8	2.8	2.9	11	0.5	2.9
Cardinal Honeyeater	66.8	0.0	40.5	18.3	20.1	40.9	0.0	8.0	34.4	17.5	8.3	29.3	91	4.3	23.9
Micronesian Kingfisher	13.4	0.0	5.8	6.1	2.9	23.4	6.0	16.0	5.7	11.7	0.0	5.9	29	1.4	8.1
Noddy Tern	82.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31	1.5	6.9
Philippine Turtle Dove	72.2	49.3	86.7	73.2	51.7	152.0	71.6	221.9	313.2	183.7	124.7	137.8	501	23.9	128.2
Chinese Pinted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Rail	0.0	0.0	0.0	0.0	0.0	29.2	6.0	2.7	5.7	2.9	8.3	2.9	15	0.7	4.8
Chestnut Mannikin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	14.6	13.9	0.0	17	0.8	3.9
Eurasian Tree Sparrow	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.7	8	0.4	2.0
Micronesian Starling	171.1	14.5	69.4	0.0	46.0	181.3	9.0	69.5	80.5	81.6	36.0	44.0	253	12.0	66.9
White Tern	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	5.9	3	0.1	1.0
Counts	2	2	2	1	2	1	1	2	2	2	2	2	21		

Table 4. Results of Northwest Field, North, and North-Central showing the mean number of birds per 100 kilometers of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks "*" indicate means significant lower ($p<.05$) and plus "+"indicate means significantly ($P>.05$) higher from preceeding year. Mann Whitney U-test was used to test for significance (Sokal and Rohlf 1969).

Species	Northwest Field FY			North FY			North-Central FY		
	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV
Yellow Bittern	10.2	11.1	108.8	2.9	3.3	113.9	5.6	4.6	81.5
Marianas Crow	45.9	24.7	53.8	0.0*	0.0	0.0	3.3+	6.1	185.2
Black Drongo	420.0	173.0	41.2	28.1	23.1	82.3	29.2	21.7	74.2
Rufous-fronted Fantail	14.6	13.6	92.7	0.0	0.0	0.0	0.0	0.0	0.0
Marianas Fruit Dove	0.5*	1.7	522.0	0.0	0.0	0.0	0.8+	2.9	346.4
Guam Broadbill	0.0	0.0	0.0	1.0*	3.4	346.4	0.0	0.0	0.0
Golden Plover	30.7	47.2	153.9	56.8	48.3	85.1	435.1	420.4	96.6
White-throated Ground Dove	2.9	2.1	74.6	0.0*	0.0	0.0	0.0*	0.0	0.0
Cardinal Honeyeater	23.9	19.9	370.1	0.0*	0.0	0.0	0.0*	0.0	0.0
Micronesian Kingfisher	8.1	6.9	85.2	0.2*	0.7	346.4	0.6+	2.1	346.4
Noddy Tern	6.9+	23.9	346.4	0.0*	0.0	0.0	0.8*	2.9	2.8
Philippine Turtle Dove	128.2	79.7	62.2	12.6	8.4	66.9	27.4	7.3	26.6
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guam Rail	4.8	8.2	4.8	0.0*	0.0	0.0	0.4+	1.4	346.4
Chestnut Mannikin	3.9*	5.9	149.1	0.5*	1.9	346.4	1.3*	3.7	1.3
Eurasian Tree Sparrow	2.0*	4.7	242.6	7.2	8.6	119.5	5.8*	8.1	139.9
Micronesian Starling	66.9	57.9	86.5	0.0*	0.0	0.0	3.3	5.8	176.9
White Tern	1.0*	2.3	233.6	0.0*	0.0	0.0	0.4+	1.4	346.4

Table 5. Species incidence of birds recorded during variable circular plot transects in three areas over three years. All counts were made during the spring months.

AREA	RITIDIAN BASIN			RITIDIAN PLATEAU			PAJON BASIN		
SPECIES	1981	1982	1983	1981	1982	1983	1981	1982	1983
Yellow Bittern	0.0	0.0	0.13	0.0	0.0	0.16	0.0	0.0	0.0
Marianas Crow	2.18	1.50	2.41	3.75	3.84	3.59	1.33	1.55	1.92
Black Drongo	1.14	0.77	1.59	0.34	0.41	1.06	0.50	0.0	0.08
Rufous-fronted Fantail	1.36	0.77	0.0	0.75	0.56	0.0	3.58	2.75	1.96
Marianas Fruit Dove	1.82	0.59	0.27	1.00	1.0	0.31	0.88	0.95	0.26
Guam Broadbill	0.41	0.36	0.09	0.41	0.00	0.0	0.25	1.20	0.21
White-throated Ground Dove	0.50	0.09	0.16	0.25	0.0	0.19	0.08	0.15	0.33
Cardinal Honeyeater	1.09	0.32	1.00	1.75	1.34	0.94	1.46	1.75	1.79
Micronesian Kingfisher	0.77	0.77	1.73	1.53	1.13	2.75	1.50	0.90	1.33
Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.05	0.0
Philippine Turtle Dove	0.50	0.50	0.05	0.53	0.59	0.25	0.0	0.25	0.21
Guam Rail	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chestnut Mannikin	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eurasian Tree Sparrow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Micronesian Starling	5.27	6.73	4.36	3.38	4.84	4.41	7.67	8.10	6.79
Bridled White-eye	0.86	0.45	0.0	0.94	0.50	0.0	4.46	4.90	0.13
White Tern	0.23	0.0	0.0	0.0	0.16	0.13	0.29	0.05	0.88
Counts	22	22	22	32	32	32	24	24	24

Table 6. Species Incidence of birds recorded on the Pajon Basin area during monthly counts in 1983.

SPECIES	MAY	JUNE	JULY	AUGUST	SEPT
Yellow Bittern	0.0	0.0	0.0	0.0	0.0
Marianas Crow	1.92	2.38	2.13	2.17	1.67
Black Drongo	0.08	0.21	0.0	0.0	0.33
Rufous-fronted Fantail	1.96	1.79	0.50	0.17	0.21
Marianas Fruit Dove	0.25	0.04	0.13	0.21	0.0
Guam Broadbill	0.21	0.71	0.92	0.67	0.50
White-throated Ground Dove	0.33	0.04	0.0	0.33	0.21
Cardinal Honeyeater	1.79	1.42	1.21	0.75	0.79
Micronesian Kingfisher	1.33	0.96	1.50	1.33	1.50
Noddy Tern	0.0	0.0	0.0	0.0	0.0
Philippine Turtle Dove	0.21	0.13	0.21	1.29	1.79
Guam Rail	0.0	0.0	0.0	0.08	0.0
Chestnut Mannikin	0.0	0.0	0.0	0.0	0.0
Eurasian Tree Sparrow	0.0	0.0	0.0	0.0	0.0
Micronesian Starling	6.79	4.83	6.0	5.13	5.75
Bridled White-eye	0.13	0.0	0.0	0.0	0.0
White Tern	0.88	1.83	0.38	0.17	0.21

An intensive survey of most of the northern and central areas for Guam Rails, using tape playback, was conducted from 23 November 1982 to 10 December 1982 along 10 routes, see Figure 2. Location of rails observed is in Figure 3.

Two separate populations were located in the Northwest Field - Ritidian and Andersen Air Force Base areas. The Northwest Field - Ritidian census route recorded twenty-two rail responses. The Andersen Air Force Base route recorded eighteen rail responses, all of which were located in the northern to northeastern parts of the base. Surveys in the Convention Weapons Area did not record any birds which may indicate that these two groups are isolated from each other. Two rail responses were recorded along the north-central route in the Mataguac area. In addition, a single rail response was recorded in the Tumon area.

Incidental sighting of birds were recorded during the Black Francolin call counts in southern Guam. Results are shown in Table 7. Only two native species were recorded, the Yellow Bittern (Ixobrychus sinensis) and Marianas Gallinule (Gallinula chlorpus guami). Because of insufficient data, population trends could not be established.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over the three routes in northern Guam.

2. Establish a working agreement with the Division F&G, CNMI to monitor the native forest birds of the Northern Mariana Islands for any trends in population decline or increase, for comparison with bird populations on Guam.

3. Implement additional studies designed to investigate the cause of decline of the native forest bird populations on Guam with emphasis on predation and disease.

4. Investigate and immediately implement measures to save Guam's native avifauna including captive propagation, predator control, as well as continuing programs to educate the public on the present situation.

5. Continue to seek Endangered Species listing for 12 native birds under the Endangered Species Act of 1973.

6. Continue natural history and breeding biology studies of the native avifauna.

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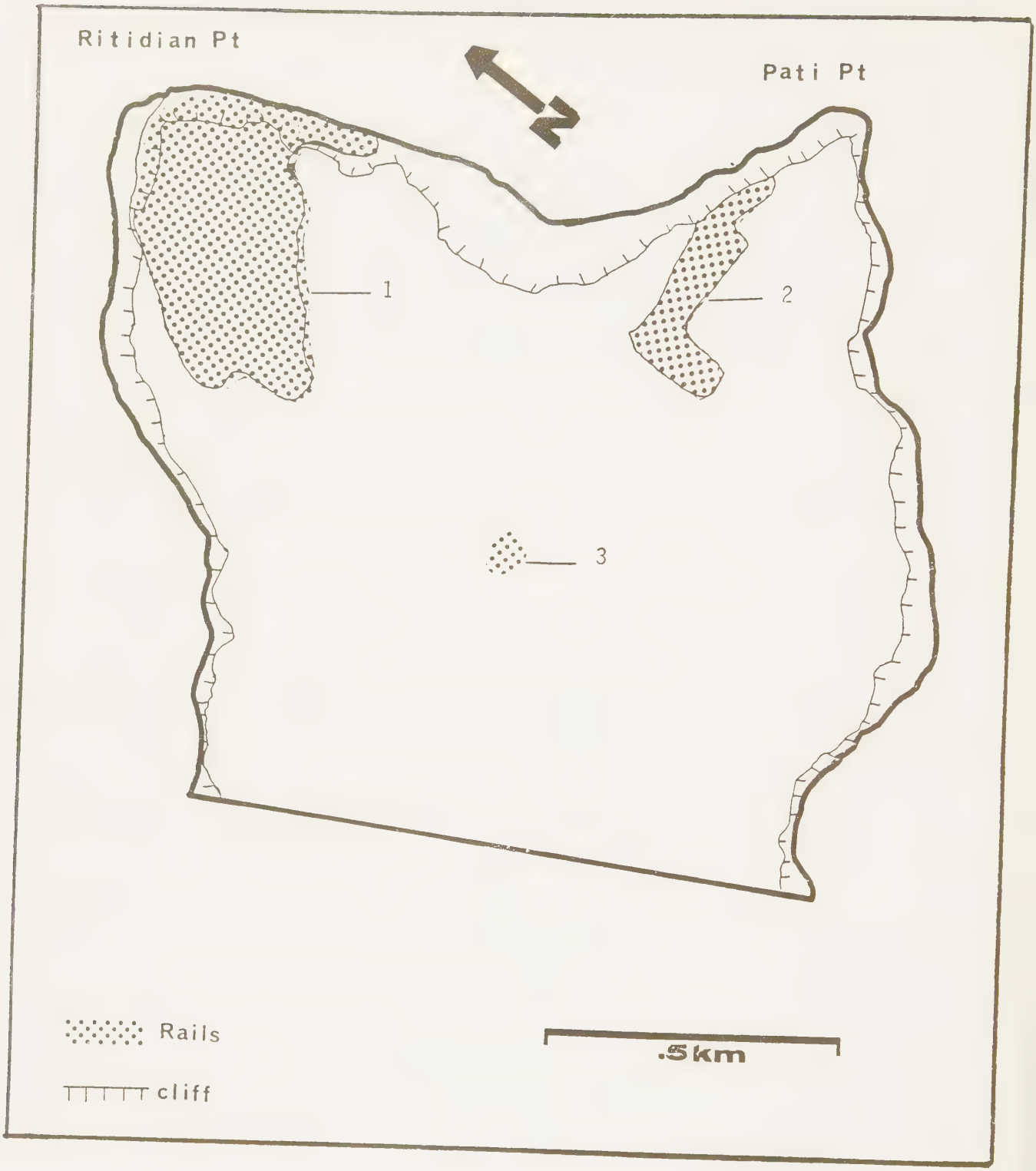

Figure 3. General location of Guam Rails observed during censuses. The numbers correspond to the following area 1-Northwest Field-Ritidian, 2-North Andersen Air Force Base, 3-Mataguac.

Table 7. Number of birds per station recorded during Black Francolin call count surveys in southern Guam.

SPECIES	Pulantat		Talofofo		Merizo		Dandan
	1982	1983	1982	1983	1982		1983
Yellow Bittern	0.36	0.33	0.19	.74	0.20		.24
Black Drongo	0.08	0.07	0.01	0.0	0.10		.05
Golden Plover	0.0	0.0	0.02	.22	0.0		0.16
Common Noddy	0.03	0.0	0.0	0.0	0.0		0.0
Philippine Turtle Dove	0.08	.19	0.09	.28	0.17	NO DATA	0.26
Chinese Painted Quail	0.30	.96	0.08	.31	0.16		0.75
Chestnut Mannikin	0.14	.15	0.12	.06	0.16		0.85
Eurasion Tree Sparrow	0.05	0.0	0.0	0.0	0.0		0.08
White Turn	0.01	.04	0.0	0.0	0.0		0.0
Marianas Gallinule	0.01	0.0	0.01	0.0	0.0		0.0
Rock Dove	0.0	.14	0.0	0.0	0.0		0.4
No. of Stations	109	84	170	179	137		80

Sokal, R.R. and F.J. Rohlf. 1969. Biometry, W.H. Freeman and Co. San Francisco. 776 pp.

Prepared by Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The current status, distribution and natural history of Marianas fruit bats.

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Guam's fruit bat population is currently estimated at 600 to 775 animals. A survey of fruit bats was conducted on eight islands north of Saipan and revealed a minimum population of 7,400 animals. Hourly counts at colonies on Guam revealed that roosting fruit bats were most visible one to three hours after sunrise. Predominantly male bachelor colonies were observed to roost separately from harem-containing colonies. A peak in bat reproduction occurred from February to July, when 32% to 45% of the adult females possessed unweaned young. Fruit bats are known to feed on 17 species of fruit, seven species of flowers and one species of leaf. A local resident found a brown tree snake that had eaten three young fruit bats, the first reported case of snake predation of bats. Seven known incidents of illegal hunting of bats occurred on Guam during the year. In FY 1983, 12,895 frozen fruit bats were imported to Guam from other islands for human consumption, an increase of 19% over the previous year.

BACKGROUND

The Marianas fruit bat (Pteropus mariannus mariannus) is endemic to the Mariana Islands and is now considered endangered on Guam. This species has been proposed for endangered status under the Endangered Species Act of 1973. The Marianas fruit bat, considered a delicacy among the indigenous people, has been under investigation by the Aquatic and Wildlife Resources Division (AWRD) of Guam since 1962 (AWRD 1964-1982). These investigations documented a steady decline in a population index throughout the 1960's (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in over-hunting and permanent habit destruction, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). Fruit bats finally received full legal protection in 1973 and in 1981, they were placed

on Guam's territorial Endangered Species List. Fruit bat abundance began to increase in 1980 and by 1982, Guam's population had grown to an estimated 850 to 1,000 animals.

OBJECTIVES

To monitor the population size and study the natural history of the Marianas fruit bat in the Mariana Islands.

PROCEDURES

1. Continue the systematic survey of fruit bat distribution and numbers initiated on Guam in 1978 and in the Commonwealth of the Northern Mariana Islands (CNMI) in 1979.

    a. Conduct annual surveys of Guam's northern cliffline with periodic surveys in other areas.

        1. Record bat numbers observed and search for additional bat colonies.

        2. For each bat observed record (where possible and applicable) flight elevation and direction, roosting tree species and height, part of plant eaten (flower, fruit, leaves, etc.), height in forage tree, sex and age (if possible), other behavior such as vocalization, copulation, etc.

    b. Conduct weekly intensive observations of bat colonies.

    c. Conduct surveys in the Northern Mariana Islands as time and manpower permit.

2. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.

3. Maintain close liaison with other bat researchers and with government officials in other island groups as well as on Guam.

RESULTS

Bat Surveys on Guam

During the first 7 months of FY 1983, Guam's major fruit bat colony roosted at North Pati Point and North Jinapsan Point. A high count of 514 adult bats was obtained at North Jinapsan Point on 18 April. Because some bats were probably hidden by thick foliage, the total number of adults in the colony was likely to be 10 to 20% higher than actual number counted. In addition, approximately 71% of the adults in the colony were harem females (AWRD 1982), of which 45% possessed young (see Natural History). These figures provide an estimate of 580 to 650 adults and 185 to 210 juveniles, or a total of 765 to 860 bats within the colony.

Following April, this colony was poached heavily and moved frequently to other sites that were relatively inaccessible and difficult to view (see Illegal Hunting and Report W-5-1-3). Because of the lack of vantage points at these locations, accurate roost counts were not possible. However, based on the amount of poaching that occurred and the number of bats seen during subsequent incomplete observations, it is felt that the colony has probably lost several hundred individuals and has declined to an estimated size of 500 to 600 animals.

In addition to the harem-containing colony, several small predominantly bachelor colonies were found during the FY, only one of which was permanent. This colony, located at North Pati Point, gradually declined in size from about 100 bats in March to about 30 bats in September.

Small numbers of fruit bats were observed throughout the year during spot checks at Taragüe Beach, Jinapsan Beach, Ritidian Point and Uruno Beach. These animals were solitary or congregated in small groups of 2 to 4 individuals and apparently never joined with the large harem-containing colony. An estimated 50 to 100 bats inhabit this 17-km-long portion of northern Guam. In addition a small population of 25 to 50 animals live in the Naval Magazine, Talofofo and Malojloj region. Based on these figures, Guam's island-wide fruit bat population is estimated at 600 to 775 animals. These figures are lower than the FY 1982 estimate of 850 to 1,000 animals.

Bat Surveys in the Northern Marianas

In conjunction with Oxford University in England and the Division of Fish and Wildlife of the CNMI, a survey of fruit bats on eight islands north of Saipan was conducted in August and September 1983. Each of the islands was visited by boat for one to several days. Islands were circled prior to landing to search for bat colonies and observation sites. Due to rugged terrain and dense fields of Miscanthus floridus, bat counts were only made from the shoreline, from easily reached inland vantage points or from the boat anchored close offshore. During counts, observers viewed nearby hillsides with 7X or 10X binoculars and recorded the number of bats seen during 10 minute intervals. Counts normally began from 1530 to 1700 hrs, when bats began emerging to feed, and lasted until darkness. All counts were of flying bats; remoteness of colonies prevented counts of roosting bats from being made. The islands of Maug and Farallon de Medinilla were not visited because of poor weather and military activity.

In contrast to the southern Marianas, fruit bats were judged to be fairly common or abundant on all of the northern islands visited except Alamagan and Uracas. A minimum population of 7,400 bats was estimated for the eight islands (Table 1). Anatahan and Pagan had the largest populations with a minimum of 3,000 and 2,500 bats, respectively. Further surveys of the large inland craters on Anatahan and Agrihan, a more lengthy survey of Alamagan, and visits to Maug and Farallon de Medinilla would have likely revealed the presence of additional bats.

At present, these numbers do not warrant the listing of this animal on the U.S. Endangered Species List for the northern islands. Although illegal, hunters from Saipan regularly visit these islands and may harvest large numbers of bats. Increased poaching or legalized hunting could be

Table 1. Estimated numbers of fruit bats and census methods used during a survey of bats in the CNMI in August and September, 1983.

Island	Size (km^2)	Estimated Bat Population	Days Spent on Each Island	Census Methods and Notes
Farallon de Medinilla	1.0	-	0	Island not surveyed due to military activity.
Anatahan	31.0	3,000+	3	Four evening counts made of north, northwest and southwest hillsides. Three of these counts made from shore and one made from boat. Large inland crater was not visited and is likely to contain more bats.
Sarigan	4.9	125	1	Three evening counts made of N half of island. Two of these counts made from hilltops and one made from shore. South half of island is not forested.
Guguan	4.1	400	4	Six evening counts made of south half of island. Five of these counts made from hillsides and one made from boat. North half of island is not forested.
Alamagan	11.1	0	1	Island poorly surveyed. Only one evening count made from north side of crater. Island should be surveyed in more detail.
Pagan	47.7	2,500	4	Four evening counts made at the village and of the east and south hillsides. Two counts of these made from inland sites, one made from shore and one made from boat.
Agrihan	46.8	1,000+	3	Four evening counts made of east and west hillsides. Two of these counts made from shore and two made from boat. Large inland crater was not surveyed. Upper west slopes was poorly surveyed. Both sites are likely to contain more bats.

Table 1. Continued

Island	Size (km^2)	Estimated Bat Population	Days Spent on Each Island	Census Methods and Notes
Ascuncion	7.2	400	1	One evening count made of south and southwest hillsides from boat. Island needs to be surveyed from land.
Maug	2.1	-	0	Island group not surveyed due to poor weather conditions.
Farrallon de Pajaros	2.0	0	1	One afternoon survey of the entire island made by boat. No habitat suitable for bats was present.
TOTAL	157.9	7,400+		

detrimental to bat populations in the future. Detailed surveys should continue, perhaps at a five year intervals, to ensure that bat populations remain at viable levels on these islands.

Bat Imports

Import permits are required for all shipments of fruit bats to Guam. There is currently no limit to the number of bats that can be requested on a single permit and retail merchants frequently inflate their requests to cover the possibility that a larger number of bats may be available at their supply source. During FY 1983, 39,346 bats were requested for import (Table 2), a slight increase of 3% from the previous year (AWRD 1982).

A total of 12,895 frozen fruit bats in 45 shipments were actually shipped to Guam from other islands in FY 1983 (Table 3). This represents a rise of 19% over the previous year and is the first increase in importations to occur since FY 1980 (AWRD 1980-1982). Guam's largest retailer of bats imported 83% of all animals brought to the island.

It should be noted that bat shipments often contain only a portion of the number of bats that are indicated on accompanying import documents. This normally occurs because customs agents fail to verify bat numbers in shipments. Several importers, when interviewed, felt that the actual number of bats imported by them during a year was as low as 50% of the total listed on their permits. Thus, official figures for the total number of bats brought into Guam during FY 1983 and past years are likely to be inflated by an unknown amount.

The origins of fruit bats imported into Guam have changed considerably during the past several years. Western Samoa and Tonga were the major sources of bats for the Guam market in FY 1983, accounting for 88% of all imported bats (Table 3). The number of frozen bats brought from these islands rose from a combined total of 2,700 animals in FY 1982 to 11,400 animals in FY 1983. In contrast, the amount of bats imported from other Micronesian islands dropped dramatically during the year. Palau supplied only 1,105 carcasses (9% of the total), the lowest quantity since records were first kept in 1975 (AWRD 1975-1982). For the first time, no bats were imported to Guam from the CNMI.

Several reasons explain the changes in origins of fruit bats imported to Guam. Local laws enacted by island governments are one cause. The Guam Endangered Species List, passed in February 1982, prohibits the further importation of P. mariannus into Guam from the CNMI. A 1982 ban on the use of firearms in Palau and a moritorium on the hunting of fruit bats since 1981 in Yap have reduced or eliminated the taking of bats in these islands. Also of importance, Samoan and Tongan fruit bats (P. samoensis and P. tonganus) appear to be more popular with local Chamorro consumers in that they are larger in size, are reported to have lower ectoparasite loads and are considered to taste better than bats (P. pelewensis) from Palau.

Census Methods

Counts of day-roosting fruit bats at colonies, using binoculars or spotting scopes from nearby vantage points, have been used successfully on Guam to

Table 2. Number of frozen fruit bats requested for import to Guam between October 1, 1982 and September 30, 1983.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Permits Issued
Western Samoa	1,000	3,400	600	500	2,525	4,000			3,000	3,050	500	3,000	21,575	37
Tonga	1,000					2,000	500	3,000	1,000	3,000	2,000		12,500	21
Palau	395	400	510	206	460	340	50		50	70	120	210	2,811	42
Truk										1,030	500		1,530	4
Ponape		50	50	70	150					110		150	580	13
American Samoa	100										100		200	2
Kosrae												100	100	1
New Guinea											50		50	1
TOTAL	2,495	3,850	1,160	776	3,135	6,340	550	3,000	4,050	7,260	3,270	3,460	39,346	121

Table 3. Numbers of frozen fruit bats imported to Guam between October 1, 1982 and September 30, 1983 based on import permits processed through Customs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Total	No. of Permits Issued
Western Samoa		1,700	1,000	1,600	1,500	1,000				1,000	500		8,350	18
Tonga								500	500	1,000	1,050		3,050	12
Palau	100	200	80	200	335		150			40			1,105	7
Ponape				50		50			50	110		50	310	6
New Guinea												50	50	1
American Samoa	30												30	1
TOTAL	130	1,900	1,080	1,850	1,835	1,050	150	500	550	2,150	1,600	100	12,895	45

estimate roost sizes (AWRD 1981, 1982). During FY 1983, hourly counts of individuals were made to determine whether bats were equally visible at all times of the day.

Counts were made on four days between 2 and 11 May at a predominantly male bachelor colony at North Pati Point. Bats at this site were found not to be equally visible throughout the day (Kruskal - Wallis ANOVA, $P < .001$). Counts of bats were highest at 0800 hrs but not significantly different from those made at 0600, 0700 and 0900 hrs (Mann-Whitney U-Test, $P < .05$; Figure 1). During the late morning and afternoon, bats grew progressively harder to see as they crawled into thicker vegetation, apparently to seek shade. In contrast, during a single count made on 18 April at the large harem-containing colony at North Jinapsan Point, the number of animals observed remained relatively high throughout the day (Figure 1). Differences in the patterns of the number of bats visible at the two sites may have been caused by differences in weather, by the amounts of the shade provided by adjacent cliffs, by the perspectives offered by different observation points and by the social organization of bats. Harem members may be more restricted to certain roosting sites and, therefore be less mobile within a tree's crown than bachelor males. It is recommended that future counts of bats at colonies should be made one to three hours after sunrise.

Figure 1. Numbers of fruit bats seen during four days of hourly counts at a predominantly male bachelor colony at North Pati Point between 2 and 11 May 1983 (solid line) and during a single day of hourly counts at a harem-containing colony at North Jinapsan Point on 18 April 1983 (dotted line). Vertical bars represent standard errors.

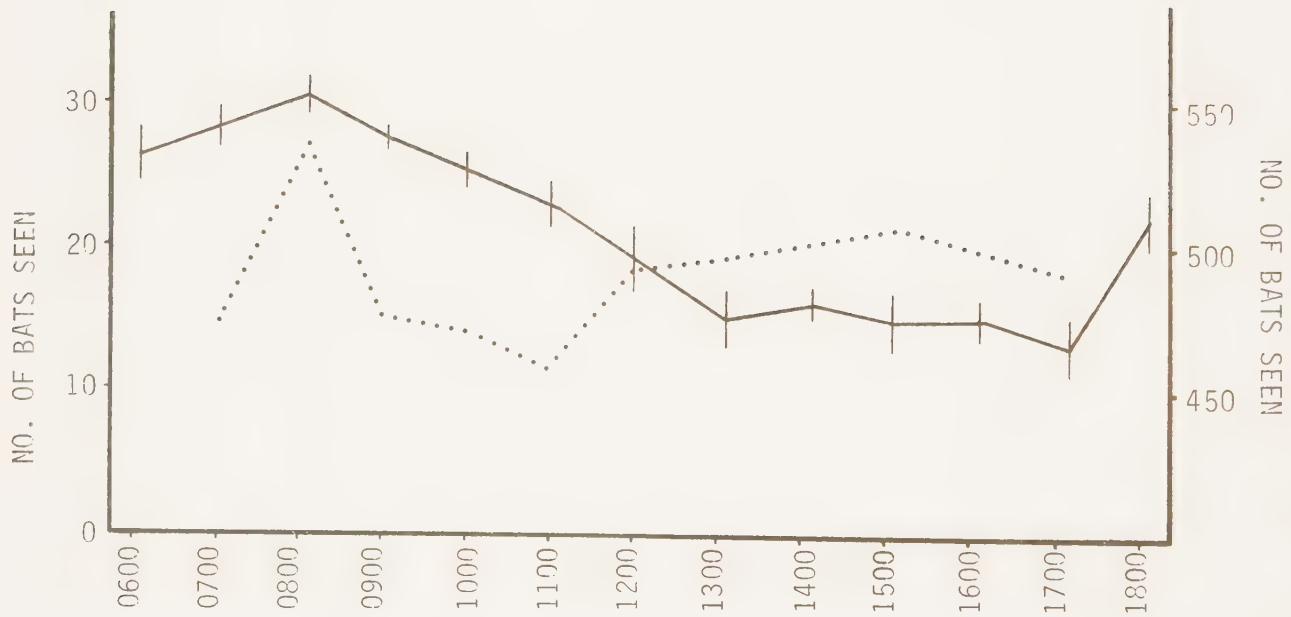

Figure 1. Numbers of fruit bats seen during four days of hourly counts at a predominantly male bachelor colony at North Pati Point between 2 and 11 May 1983 (solid line) and during a single day of hourly counts at a harem-containing colony at North Jinapsan Point on 18 April 1983 (dotted line). Vertical bars represent standard errors.

Natural History

Social Organization - Guam's fruit bats roost both colonially and solitarily. A single large colony of bats was present in northern Guam throughout FY 1983. Within this colony, bats segregated sexually and roosted in harems comprised of an adult male and 2 to 15 females, in large predominantly male bachelor groups or singly (males only) on the periphery of the colony (AWRD 1981, 1982).

During FY 1983, several bachelor colonies were found that contained an estimated 10 to 125 animals. The first of these was observed at North Pati Point after the movement of the harem-portion of the colony to North Jinapsan Point in January. Initially, about 100 males and 5 females, in 2 small harems, were present in the roost. By April, the females had departed and the colony slowly shrank to about 40 males in May. An unknown number of females returned briefly to the site for several weeks in June and harems formed about them. This occurred after a poaching incident at the main colony at South Jinapsan Point. Between late June, when all females again left the roost, and September, the North Pati Point colony maintained a constant size of about 30 males. Males within this colony roosted 1 to 10 m apart, whereas those found in bachelor groups within large harem-containing colonies formed tighter assemblages with most members spaced only .3 to 1 m apart.

Three other small groups of bats, each with 10 to 25 animals, were observed in FY 1983 but unfortunately, the sexes of members were determined for only one group. This cluster contained 14 males. A second group that roosted in a loosely-aggregated manner similar to the bachelor colony at North Pati Point was probably also made up mostly of males. Each of the three groups was temporary and remained at its roost site for only 2 to 4 weeks. Two of the groups occurred within 250 m of the main harem-containing colony. Disturbances such as poaching, that disrupt the main colony and cause it to move, may be responsible for causing small groups like these to separate away and temporarily form.

Reproduction - Most species of Pteropus have a well defined breeding season (Baker and Baker 1936). In species found north of latitude 4°N, young are generally born in March and April while species found south of this latitude generally produce young in September and October. However, in Micronesia, this trend has not been substantiated. In Ponape, Jackson (1962) collected unweaned P. molossinus in February, September, and November, suggesting a prolonged breeding season for this species. Unweaned young of P. mariannus have been found throughout the year on Guam (Perez 1972, AWRD 1982).

Beginning in July 1982, attempts were made to observe a minimum of 50 harem females each month to determine whether they possessed unweaned young. Unfortunately, data were collected for only five months during FY 1983 because frequent movements by the colony to new and often hard-to-view roosting sites prevented observations. Data thus far collected indicate that a peak in the number of young born occurs from February to July (Table 4). During the eight months, a mean of 27.8% of all females possessed young with a monthly high of 45.2% of females with young occurring in April.

Table 4. Number of harem females observed with unweaned young at North Pati Point and North Jinapsan Point from July 1982 until April 1983. Data for July through September 1982 is taken from AWRD (1982).

	No. of ♀♀ observed	No. of ♀♀ without young	No. of ♀♀ with small young	No. of ♀♀ with medium young	No. of ♀♀ with large young	% of ♀ with young
July	52	35	5	12	0	32.7
August	74	59	3	12	0	20.3
September	79	68	5	4	2	13.9
October	58	48	4	6	0	17.2
November	52	44	2	5	1	15.4
February	61	40	4	9	8	34.4
March	76	47	2	13	14	38.2
April	84	46	5	14	19	45.2
TOTAL	536	387	30	75	44	27.8

Foods of Bats - Species of Pteropus feed exclusively upon a wide variety of fruits, flowers and leaves. A literature survey conducted by Marshall (1983) found that Pteropus are known to use 62 genera of fruit, 26 genera of flowers and 3 genera of leaves as food.

During FY 1983, information was gathered on the foods of Marianas fruit bats by directly observing finding evidence of bats feeding, by examining feces, by interviewing residents and by reviewing published accounts. Twenty-two species of plants are known to be eaten by bats (Table 5). This includes 17 species of fruit, seven species of flowers and one species of leaf. When available, it appears that favored foods include Artocarpus altilis, A. mariannensis, Ceiba pentandra, Ficus sp., Pandanus tectorius and Terminalia catappa.

Feeding signs of bats were found on the ground directly under several species of fruiting trees (A. marianensis, Cycas circinalis, Neisosperma oppositifolia, Ochrosia mariannensis and Tristeropsis acutangula). Evidence of recent feeding normally included large seeds or pieces of partially eaten fruit which had been dropped from feeding sites above. Pellets of fruit pulp, which have been chewed and pressed against the palate to remove the fruit juices and then spit out, and droppings were also sometimes found at these sites. Under A. mariannensis, fresh leaves with chewed stems and twigs with chewed tips were often present.

Table 5. Food plants used by Marianas fruit bats.

Species	Location	Notes	Source
Annona reticulata	Guam	Fruit reported to be eaten.	Safford (1905), Linsley (1934) E.H. Bryan in Stone (1970)
Artocarpus altilis	Anatahan, Rota	Fruit observed to be eaten in August. Reported to be eaten on Rota. Appears to be a highly preferred food.	this study, Linsley (1934), local residents
Artocarpus mariannensis	Guam, Rota	Partially eaten fruit and chewed fruit pulp found on ground under trees from June to December. Chewed leaf stems found from May to February. Reported to be eaten on Rota. Appears to be a highly preferred food.	this study, Safford (1905), Linsley (1934), Perez (1972), local residents
Carica papaya	Guam	Fruit reported to be eaten.	Stone (1970), Perez (1972), local residents
Casuarina equisetifolia	Rota	Flowers reported to be eaten.	local residents
Ceiba pentandra	Guam, Rota	Flowers reported to be eaten. Appears to be a highly preferred food. One tree on Rota is a favorite poaching site. On Guam, this tree flowers from January to March.	Perez (1972), local residents
Cocos nucifera	Guam, Anatahan, Sarigan	Flowers observed to be eaten in August and September.	this study, Perez (1972), AWRD (1979)
Cycas circinalis	Guam	Partially eaten fruit and chewed fruit pulp found on ground under trees in November, January and February. Fruit fiber found in feces.	this study
Cynometra ramiflora	Guam	Fruit reported to be eaten.	Safford (1905)
Dendrocnide latifolia	Guam	Flowers (♂ inflorescences) observed to be eaten.	AWRD (1979)

Table 5. Continued

Species	Location	Notes	Source
Elaeocarpus sphaericus	Guam, Rota	Fruit and flowers reported to be eaten.	Linsley (1934), Safford (1910), local residents
Erythrina variegata	Rota, Guam	Flowers reported to be eaten. On Guam, this tree flowers from January to March.	local residents
Ficus sp.	Guam	Fruit observed to be eaten. Fruit pulp and seeds found in feces during May to July and November. Appears to be a preferred food.	this study, AWRD (1979)
Hernandia nymphaeifolia	Guam	Fruit observed to be eaten.	AWRD (1979)
Mangifera indica	Pagan	Fruits stripped of pulp found under trees in August. Recently expended shotgun shells found around these trees indicating that poaching had taken place.	this study
Musa sp.	Anatahan, Guam	Foraging behavior (but not actual feeding) seen in August. Cultivated Musa reported to be eaten on Guam.	this study, local residents
Neisosperma oppositifolia	Guam, Sarigan	Partially eaten fruit and chewed fruit pulp found beneath trees in September, November and December. Bats heard in trees at night. However, lack of intense feeding indicates this is not a preferred food species.	this study
Ochrosia mariannensis	Guam	Partially eaten fruit and chewed fruit pulp found under a tree in February.	this study
Pandanus tectorius	Anatahan, Guguan, Guam, Rota	Fruit observed to be eaten in August and September. Bats observed to carry seeds in their mouths. Appears to be a highly preferred food.	this study, Linsley (1934), local residents, Safford (1905)
Psidium guajava	Guam	Fruit reported to be eaten.	Safford (1905, Linsley (1934)
Terminalia catappa	Guguan	Fruit and flowers observed to be eaten in September. Appears to be a preferred food on Guguan.	this study
Tristiropsis acutangula	Guam	Partially eaten fruit and chewed fruit pulp found on ground under a mature tree in February.	this study

Sixty-eight feces from bats were collected from low vegetation and the ground below feeding sites and abandoned roosts. These were then examined with a dissecting microscope for the presence of small seeds, fruit pulp and pieces of epicarp. Most droppings contained Artocarpus fruit pulp (47%), Ficus seeds or fruit pulp (13%) or C. circinalis fruit pulp (10%) but these figures are likely to be highly biased by the small number of collection sites and times. Other droppings contained unidentified fruit pulp (21%) and unknown seeds or flower-part-like fibers (12%). Where fruit bats are numerous and biologists have a good knowledge of local flora, the collection and analysis of bat droppings may be a productive method in partially revealing the feeding habits of bats. This method is most useful where small fruit (1 cm) or fruit with tiny seeds such as Ficus are consumed by bats.

Predation and Accidents - Little is known about the causes of natural mortality in Marianas fruit bats. With the introduction of the brown tree snake (Boiga irregularis) to Guam after World War II the first potentially serious predator of bats reached the island. Only one case of predation on bats by snakes has been reported. A local resident related finding a 2.5 m long snake with three young fruit bats in its stomach during the fall of 1982 between Northwest Field and Ritidian Point. He estimated the bats to be 12 to 15 cm long and have a wingspan of 25 to 30 cm. Other evidence, although circumstantial, further indicates that snakes may be having a detrimental effect on bats. The number of large juveniles present in the main colony rose dramatically when roosting sites changed in December from North Pati Point to North Jinapsan Point (Table 4). Sightings of snakes and molted snake skins by biologists and residents indicate that snakes are probably less common near Jinapsan Point and may have invaded there only recently. They have probably inhabited Pati Point several years longer. Young bats of this size are particularly vulnerable to predation since they are not yet able to fly but are too large to be carried by their mothers during nighttime feeding trips. Thus, they are left overnight at the roost site and may be susceptible to nocturnal predators.

Accidents of various types may occasionally kill fruit bats. At 1815 on 25 December 1982, a C-130 cargo plane taking off from Andersen Air Force Base (AAFB) collided with a bat over Pati Point at an elevation of 30 m above the ground. Although airplane-bird strikes occur regularly on Guam, this is the first collision known to involve fruit bats.

Illegal Hunting

Poaching continues to be probably the major factor preventing a recovery of Guam's fruit bat population. Four known cases and three reliable reports of illegal hunting occurred in FY 1983. Four of these, and possibly a fifth, involved hunting at colony sites. These are documented here to demonstrate that poaching is still a major problem which regularly occurs on Guam.

A resident of Jinapsan Beach heard several shots fired at the North Jinapsan Point colony on 11 April and 1 May. The bats returned to the roost following the first shooting, however, they abandoned the site after the second incident. On 17 May, a man-made clearing 20 m in diameter was discovered adjacent to a large breadfruit tree (A. mariannus) on a ledge east of Ritidian Point. Thirty-five empty shotgun shells were found in the

clearing, having apparently been fired during the previous breadfruit season (June to December 1982). On 30 May at 1130, a poaching incident took place that involved two hunting parties working together at the South Jinapsan Point colony. First, five shots were fired at a small group of bats roosting at the bottom of the cliffline. Several minutes later, nine more shots were heard at the main colony site on top of the cliff. Later that day, Conservation Officers discovered a man-made clearing 10 m in diameter and located on the clifftop edge 350 m southeast of the roost. Twenty-eight shotgun shells, probably fired during the previous month, were collected there. On 9 or 10 July, a fisherman saw "about 100" bats flying from the Pajon Point area at 1000. No shots were heard, but it is likely that human intruders had approached quite close to the colony roosting there. On 24 September between 1900 and 2400, Conservation Officers heard about 25 shots fired from a clifftop clearing that was 30 m in diameter and located east of the Conventional Weapons Area on AAFB. This occurred on an evening with a full moon. A final incident likely involved human disturbance occurred when the large colony at North Pati Point abandoned that site in late December. However, because of the continued residence of some bats at the location, a search for poaching evidence was not made.

Insectivorous Bats

During the year, caves were searched for the presence of Emballonura semicaudata but no bats were found. E. semicaudata has not been seen recently on Guam (since 1971) or other islands in the southern Marianas (T.O. Lemke, pers. comm.). A final report summarizing the cave surveys will be written in FY 1984.

In March, the carcass of a small insectivorous bat was found on a taxiway at AAFB and was turned over to the AWRD. Originally thought to be a specimen of E. semicaudata, the bat was sent to J.E. Hill at the British Museum (Natural History) for positive identification. Instead, however, the bat was identified as a specimen of the little brown bat (Myotis lucifugus) from North America. Undoubtedly, this bat arrived accidentally on Guam aboard an air force plane. A report describing in greater detail the discovery of this bat will be submitted for publication during the next fiscal year.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may prove to be productive since continued poaching at bat roosts on Rota (T.O. Lemke, pers. comm) could cause large numbers of bats to move to Guam.

2. Continue to make observations at Guam's bat colonies. Information should be gathered on reproductive biology, behavior within the colonies, and the sex and number of bats present.

3. Known bat roosting areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching is a serious problem.

4. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a relatively large bat population is found but where logistics prevent the CNMI from doing extensive field work. Emphasis of this project would be to identify colonies should they move between Guam and Rota.

5. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources.

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Report prepared by Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Movement patterns and habitat utilization of Marianas fruit bats.

PERIOD COVERED: October 1, 1982 to September 30, 1983

JOB OBJECTIVES: To determine movement and activity patterns, home range size, and patterns of habitat utilization, with an emphasis upon roost site fidelity and inter-island migration.

SUMMARY

Observations of Guam's only known harem-containing colony of Marianas fruit bats (Pteropus mariannus mariannus) provided data on roost site fidelity, and roost site terrain and vegetation. Six roosts were used by the colony during the year. Known and suspected poaching incidents were involved in the abandonment of at least four of the five roosts. Fidelity of bats to former roosting sites appears to be low. Large Ficus trees along clifflines characterized bat roosts.

BACKGROUND

Little is known about the movements of Marianas fruit bats on Guam. Low population levels and the tree-dwelling habits of bats have made capture attempts and banding studies impractical. In the past, most information has come from incidental sightings and reports from local citizens (Perez 1972). Knowledge of movements, particularly between islands, is necessary in formulating proper cooperative management measures for bats in Guam and the Commonwealth of the Northern Marianas.

PROCEDURES

1. Develop methods and techniques for capturing, marking and instrumenting fruit bats.

    a. Develop and test marking, banding or tagging methods.

    b. Develop and test methods of instrumenting bats with radio-telemetry equipment.

2. Implement a bat banding or marking program.

3. Determine bat movements and activity patterns.

   a. Telemetry study to emphasize roost-site fidelity, activity patterns, inter-island migration, and habitat utilization (to be developed).

   b. Record roosting sites of bat colonies and observe activity patterns of bats at them.

4. Determine habitat utilization of bats.

   a. Ordination of habitat in bat feeding areas through multi-variate analysis of telemetry data (to be developed).

   b. Visit colony roosting sites and record the size and abundance of the vegetation present.

RESULTS

The radio telemetry portion of this job remained in the planning stage during this segment pending the development of an effective method of attaching radio transmitters to fruit bats.

Roost Site Fidelity

Guam's only known harem-containing colony of fruit bats resided at six sites along the island's northern cliffline during FY 1983 (Table 1). One of these sites, North Pati Point, was used for 18 consecutive months dating back to June 1981 (AWRD 1981, 1982). After this roost was abandoned by the main colony in December 1982, a smaller predominantly male bachelor colony continued to use the site through 30 September (see report W5-1-2). Other locations were inhabited by the main colony for much shorter periods. South Jinapsan Point, East Ritidian Point and South Pajon Point were each used for less than one month. Known poaching incidents or suspected attempts were involved in the abandonment of at least four of the five roosts (see report W5-1-2). Other species of Pteropus, when undisturbed, have been reported to roost for many years at the same colony locations (Ratcliffe 1932, Neuweiler 1969, Marshall 1983).

An attempt to measure the fidelity of fruit bats to roost sites was made by contacting six former biologists with the Division of Aquatic and Wildlife Resources and questioning them about the exact locations of former roosts. They identified 17 locations that were used as far back as the late 1960's. Wheeler and Aguon (1978) also reported the locations two roosts that were used temporarily in 1978. Only two of these sites are among the eight used by the large harem-containing colony since January 1981 (Table 1; AWRD 1981, 1982). North Pati Point has been occupied almost continuously since February 1980 except for a brief month-long period during May and June 1981 when it was temporarily abandoned (AWRD 1980-1982). Bats also resided at this roost during the 1960's (G.S.A Perez pers. comm.) and briefly during 1978 (Wheeler and Aguon 1978). North Jinapsan Point was the site of temporary roosts for three to five bats on three occasions from June to September 1978 (Wheeler and Aguon 1978). Thus, it appears that fruit bats only occasionally return to roost at former colony sites.

Table 1. Time periods of use of six roost sites by a large harem-containing colony of Marianas fruit bats.

Site	Period Used by Bats
North Pati Point	24 June 1981 to 25 December 1982[1]
North Jinapsan Point	25 December 1982 to 1 May 1983
South Jinapsan Point	1 May to 30 May 1983
East Ritidian Point	30 May to 27 June 1983
South Pajon Point	27 June to 9 July 1983
North Tarague Cliffline	9 July to present

[1]North Pati Point was used continuously through September 1983 by a predominantly bachelor colony (see Report W5-1-2).

Terrain and Vegetation at Bat Roosts

Characteristics of vegetation and terrain were recorded at four abandoned bat roosts during FY 1983. Visits to the North Pati Point and North Tarague sites were not made because of the continued residence by bats. Cliffline roosts were highly preferred as roosting sites; all occurred along or with 70 m of the edge of the escapement (Table 2). However, the elevations and slopes of these sites varied considerably, ranging from 50 to 165 m and from less than 5° to 40°, respectively (Table 2). The substrate of all locations consisted mainly of limestone boulders and loose rocks with patches of thin soil.

Table 2. Terrain characteristics of four fruit bat roosts.

Roost	Elevation (m)	Slope	Cliffline location
North Jinapsan Point	100-120	20-30°	on a ledge about ½ of the way up the cliffside
South Jinapsan Point	165	<5°	top of the plateau, 70m from the cliff edge
East Ritidian Point	75-90	30-40°	on a steeply sloping hillside about 1/3 of the way up the cliffside
South Pajon Point	50	0-20°	on top of a single tall protruding boulder near the bottom of the cliff-side

All roosts were located in mature limestone forest with Ficus sp., Aglaia marianensis, nammea odorata and Cycas circinalis the most common trees present (Table 3). Large Ficus are an important component of bat roosts with most bats preferring to roost in this type of tree (AWRD 1981, 1982). Microsorum punctatum, Asplenium nidus, and Tectaria crenata were the most common ferns present at these sites (Table 4).

RECOMMENDATIONS

1. Finalize the acquisition of all radio telemetry equipment.

2. Evaluate the performance of radio collars as the best method for attaching transmitters to fruit bats once the telemetry study begins.

3. Develop methods of capturing fruit bats. One potential method should be to search fruiting trees in known feeding areas and attempt to capture visiting bats with mist nets.

4. Pattern telemetry studies after those of Heithaus and Fleming (1978) and Morrison (1978) to determine fidelity to day roosts, periods of activity, consistency in use of feeding areas, locations of feeding areas, foraging distances and behavior, food species, and inter-island movements.

5. Continue regular observations and counts at known fruit bat colonies. Continue to visit colony roost sites after they have been abandoned to record the habitat components present.

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Table 3. Abundance of trees and shrubs at four fruit bat roosts. (Key to abundance: xxxx = abundant; xxx = common; xx = uncommon; x = rare, only one or two individuals present; - = absent.)

Species	Height (m)	North Jinapsan Point	South Jinapsan Point	East Ritidian Point	South Pajon Point
Ave. Height of forest canopy		10m	12m	12m	6m
Ficus sp.	6-15	xxx	xxxx	xxx	xxx
Aglaia mariannensis	1-10	xxxx	xxxx	xxx	xxx
Mammea odorata	1-10	xxx	-	xxxx	xx
Macaranga thompsonii	6-10	xxxx	x	xx	-
Guettarda speciosa	6-10	x	-	xx	-
Tristeropsis acutangula	6-12	xx	xx	-	-
Artocarpus marianensis	8-10	-	x	-	-
Pouteria obovata	10	x	-	-	-
Pandanus tectorius	1-10	x	-	x	x
Eugenia reinwardtiana	1-9	xxx	xx	-	-
Premna obtusifolia	6-8	x	xx	-	-
Dendrocnide latifolia	4-8	xx	-	-	-
Guamia mariannae	1-6	x	xxxx	x	-
Pipturus argenteus	3-6	xxxx	-	-	-
Cordia subcordata	2-6	x	-	-	xx
Neisosperma oppositifolia	6	-	x	-	-
Cycas circinalis	1-5	xxxx	xxx	xxxx	xxx
Triphasia trifolia	2-5	xxxx	xx	-	xxx
Carica papaya	<1,4-5	-	-	xx	-
Pisonia grandis	5	-	-	-	xx
Morinda citrifolia	1-5	-	x	x	x
Randia cochinchinensis	3-4	xxx	-	-	x
Psychotria sp.	2-4	x	-	-	xx
Cynometra ramiflora	3-4	xx	x	-	-
Pandanus dubius	2-4	-	x	-	-
Alyxia torresiana	1-3	x	-	-	-
Piper guahamense	1-2	-	xx	xxx	-
Maytenus thompsonii	1-2	xx	-	-	-
Eugenia palumbis	1	-	-	-	x
Phyllanthus marianus	<1	-	-	-	x
*Casuarina equisetifolia	2-5	xxxx	-	xxx	-
*Scaevola taccada	1-3	xx	-	xxx	-
*Bikkia tetandra	1-3	xxx	-	-	-

*Species found exclusively on cliff sides above main roost areas. These trees were used by some roosting animals.

able 4. Abundance of epiphytes, vines, terrestrial ferns and herbs at four fruit bat roosts. (Key to abundance: xxxx = abundant; xxx = common; xx = uncommon; x = rare, only one or two individuals present; - = absent.)

Species	Vegetation Class	North Jinapsan Point	South Jinapsan Point	East Ritidian Point	South Pajon Point
Microsorum punctatum	epiphyte	xx	xxxx	xxx	-
Pyrrosia adnascens	epiphyte	-	xxx	xx	xx
Asplenium nidus	epiphyte	xxxx	xxx	x	-
Nephrolepis acutifolia	epiphyte	-	xxx	x	-
Polypodium scolopendria	epiphyte	xx	x	-	x
Asplenium pellucidum	epiphyte	-	xx	-	-
Taeniophyllum mariannense	epiphyte	-	-	xx	-
Asplenium laserpitiifolium	epiphyte	-	x	-	-
Flagellaria indica	vine	xx	xxx	-	xxx
Passiflora suberosa	vine	xxx	-	xxx	xx
Caesalpinia major	vine	-	-	-	xxx
Tectaria crenata	terrestrial fern	xxxx	-	xxx	-
Asplenium polyodon	terrestrial fern	xxx	-	-	xxx
Nephrolepis hirsutula	terrestrial fern	xx	-	-	-
Elatostema calcareum	herb	xx	-	-	x
Peperomia mariannensis	herb	-	x	x	-
Hedyotis sp.	herb	-	-	-	x

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Report prepared by Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 5

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

A study of the impact of avian disease on Guam's bird populations is in progress. One sentinel study has been completed, and all birds remained healthy.

BACKGROUND

Guam's native birds have decline drastically in recent years. With the exception of an occasional bittern and a small swiftlet population, none of the native land birds occur in the southern two-thirds of Guam, although all once occupied this area.

The avian decline on Guam is dramatically similar to the decline of Hawaii's native birds. Warner (1968) suggested that extinction of nearly half of the endemic Hawaiian land avifauna and restriction of the remainder to high-mountain forests was due to the pathogenicity of avian malaria, pox, and other possible introduced diseases. On islands, such as Hawaii or Guam, where avian hosts may have lost resistance or never evolved resistance, the introduction of new pathogens or vectors may be devastating. Thus, an in-depth study of avian disease on Guam is being conducted to determine if disease is the cause of the avifauna decline.

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Conduct sentinel studies to determine presence of avian disease.

    a. Micronesian Starling experiment.

        In December 1982, sixteen Micronesian Starlings (Aplonis opacus) were captured on Cocos Island. These were monitored for 30 days in the DAWR lab. The starlings were

then transferred to a large outdoor cage in central Guam. The cage was placed in second-growth vegetation near an ephemeral stream. Half of the cage was mosquito-proofed using an inner layer of mosquito netting and an outer layer of screen, and the other half was open chicken wire. Six starlings were controls and ten exposed. Following an exposure of 30 days, all birds were monitored for an additional 60 days in the laboratory before being released in an isolated ravine forest in southern Guam. Blood smears were taken before and after the experiment.

b. Bridled White-eye experiment.

During May 1983, sixteen Bridled White-eyes (Zosterops conspicillata) were mist-netted on Saipan and transferred to Guam in mosquito-proofed cages. These birds were monitored for several months, and presently eight are being exposed in northern Guam.

2. Supplement Study E-1-1-6 (Avian Disease).

RESULTS

All Micronesian Starlings remained healthy throughout the experiment. Blood smears and swabs for bacteria and viruses were analyzed by the U.S. Fish and Wildlife National Wildlife Health Laboratory. All samples were negative for disease.

Results are forthcoming for the Bridled White-eye experiment.

RECOMMENDATIONS

Conduct a final sentinel experiment using disease-free canaries, Coturnix quail, chickens, and possibly additional white-eyes in northern Guam in the 1984 rainy season (July or August).

LITERATURE CITED

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Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a status report and species management plan for the native doves of Guam.

PERIOD COVERED: October 1, 1982 to September 30, 1983

OBJECTIVE

To develop a recovery program and species management plan for the native doves of Guam.

SUMMARY

This job, which has been inactive during recent segments, is deemed completed due to the publication of "The Native Forest Birds of Guam" by J. Mark Jenkins (Ornith. Mono. No. 31).

BACKGROUND

In 1977, former biologist Nicholas Drahos prepared a manuscript entitled "The Doves of Guam", summarizing the natural history of the three species of dove found on Guam. For various reasons, that manuscript was not published and jobs were created to publish separate status reports for the introduced Philippine Turtle Dove (Streptopelia bitorquata) and the indigenous White-throated Ground Dove (Gallicolumba x. xanothura) and Marianas Fruit Dove (Ptilinopus roseicapilla). These jobs have been relatively inactive during recent segments.

PROCEDURES

1. Synthesize material from past reports and manuscripts and all available data.

2. Identify management and research needs and make recommendations for future work.

RESULTS

During 1978 and 1979, biologist J. Mark Jenkins devoted considerable time and effort to collecting through direct observation, literature review, and review of field notes and file data, information on the life history of the native forest birds of Guam, including the two indigenous species of dove.

Jenkin's efforts culminated in a manuscript entitled "The Native Forest Birds of Guam", recently published as Ornithological Monograph No. 31 by the American Ornithologists Union. The publication of this monograph summarizes what is known of the natural history of the White-throated Ground Dove and the Marianas Fruit Dove and is deemed to have fulfilled the objectives of this job.

RECOMMENDATIONS

This job should be terminated and the development of an actual recovery plan for these species should be coordinated with the U.S. Fish and Wildlife Service once they are formally listed as endangered species.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 3
JOB NO.: 2

JOB TITLE: Identification and Acquisition of Land Useful as Guam Rail Habitat

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Steps have been taken to acquire certain land areas that have value as habitat for Guam Rail.

BACKGROUND

As previously reported, the Guam rail has declined drastically in number and distribution, and is now restricted to the northern half of Guam. In order to prevent further decline rail has been recommended for endangered status, and most of its current range proposed as critical habitat. Some of the most valuable rail habitat is currently under military control. Some of these lands, however, have been identified as being excess to military needs and may become available for transfer to the Government of Guam. In order to safeguard these lands for the protection of the Guam rail and other native birds, the Division has been working closely with the Bureau of Planning in identifying the lands best suited as rail habitat and in preparing applications for acquisition of these lands.

OBJECTIVES

To set aside and protect valuable Guam rail habitat using existing legal authorities.

PROCEDURES

1. Identify and attempt to acquire land that provides habitat for the Guam rail.

2. Work closely with the Bureau of Planning in preparing applications for the transfer of excess military land to the Government of Guam.

RESULTS

The Division has recommended that a large of area of northern Guam be declared critical habitat for the protection of the Guam rail. This species is a candidate for endangered status under the Federal Endangered Species Act of 1973. Although rails were recommended for listing in 1978, bureaucratic and administrative procedures have precluded positive action to date. Action on the listing proposal is expected in 1984, but the designation of critical habitat is now not expected to be concurrent with the endangered species listing. If the U.S. Fish and Wildlife Service determines that critical habitat is necessary, that designation will follow at a later date.

The Division has worked closely with the Bureau of Planning to identify excess military land that has value as rail habitat and to prepare applications for the transfer of these lands to the Government of Guam. In excess of 1600 acres have been so identified. Draft applications have been prepared for most of these lands; as they become available, these applications will be finalized and submitted to the General Services Administration.

RECOMMENDATION

Continue with current requests for the acquisition of designated excess military land for protection of Guam rail habitat.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 4
JOB NO.: 2

SUB-PROJECT TITLE: Threatened and Endangered Species

JOB TITLE: Gallinule Habitat Survey and Protection

PERIOD COVERED: October 1, 1982 to September 31, 1983

SUMMARY

Some wetland survey work was done in conjunction with the inventory and mapping activity of the National Wetlands Inventory.

BACKGROUND

The Guam Gallinule is one of several species of bird native to Guam that has declined greatly in recent years and that has been recommended for listing as an endangered species under the Federal Endangered Species Act of 1973. The gallinule currently enjoys legal protection under the Endangered Species Act of Guam (P.L. 15-36). Although the causes of the decline of gallinule populations are not definitely known, it is believed that loss of available habitat through land-use changes may be a factor with this species.

OBJECTIVES

1. To identify, set aside, and protect valuable Guam gallinule habitat using existing legal authorities.

2. To determine the present population of Gallinule on Guam.

3. To develop management and recovery programs for the Guam gallinule.

PROCEDURES

1. Inventory and map all wetlands on Guam as a part of the National Wetlands Inventory, in cooperation with the U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers.

2. Conduct call-count surveys, transect counts, and other census methods in wetland locations to determine the present population of gallinule on Guam.

3. Identify and attempt to acquire land that provides habitat for the Guam gallinule.

   a. Designate selected areas of private land as "Agriculture Preserves" and enter into contracts with landowners for protection of gallinule habitat.

   b. Prepare applications for the acquisition of surplus military land that provides habitat value for gallinule.

4. Develop habitat management and improvement programs that result in a increase in available habitats, habitat, and gallinule populations.

RESULTS

Personnel from the National Wetlands Inventory program of the U.S. Fish and Wildlife Service visited Guam in early 1983 to conduct field inspections of wetland areas as a part of the ground-truthing of the wetland mapping that they were doing from existing aerial photography. Division staff spent a considerable amount of time with the mapping team, both in the field and in the office. After the wetland maps for the entire island were completed, Mr. Dennis Peters returned to Guam in June, where he held a workshop on the use of the wetland maps. He also visited a number of wetland sites with our staff to check the draft maps for accuracy. Once completed, these wetland maps should be a valuable planning and management tool.

Due to manpower constraints, it was not possible to conduct call-count surveys or transect counts on a regular basis. Incidental observations of gallinule were made on wetland areas visited in the course of other projects. The gallinule appears to make use of transient wetlands, as breeding pairs have been observed in a wetland near the Department of Agriculture's office annually over the past several years. During the report period, two freshly dead gallinule were found near the Department of Agriculture's office; one in a Forestry Division nursery and another alongside the road.

The Division has worked closely with the Bureau of Planning to identify excess military land that has value as gallinule habitat and to prepare applications for the transfer of these lands to the Government of Guam. An application for the acquisition of the Agana Spring area was prepared and approved; actual transfer of this property is pending. A number of additional parcels of land that have definite habitat potential for gallinule are pending release; applications will be finalized and submitted as they become available.

RECOMMENDATIONS

Continue with requests for the acquisition of designated excess military land for the protection of gallinule habitat. As staff time becomes available,

begin preparation of habitat management and improvement programs for the benefit of Guam's gallinule population.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 5
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management Plan for the Vanikoro Swiftlet

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

Literature was reviewed and numerous caves were surveyed for sign of swiftlet activity.

BACKGROUND

In 1977, a manuscript entitled "The Status of the Edible-Nest Swiftlet on Guam" was prepared by former Biologist Nick Drahos. For various reasons, the manuscript was not published and a job was created to prepare a status report and management plan for this species on Guam, based upon a synthesis of all available data plus updated status and distributional surveys.

OBJECTIVES

To develop a status report and species management plan for the Vanikoro Swiftlet.

PROCEDURES

1. Synthesize all available data and material in past reports and manuscripts.

2. Supplement the above with current population counts, cave surveys, etc.

3. Identify management and research needs and make recommendations for future work.

RESULTS

Activity during this segment consisted mainly of continued literature review. In addition, numerous caves were surveyed for sign of historical swiftlet use and to determine the current distribution of the Vanikoro Swiftlet (*Aerodramus vanikorensis bartschi*) on Guam. These surveys are

continuing and all data will be presented in a final report to be issued in Segment 21.

RECOMMENDATIONS

Complete surveys and prepare final report summarizing all available data and describing the current status of the Vanikoro Swiftlet on Guam during Segment 21.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 6
JOB NO.: 1 (Incl. Jobs 1-3)

JOB TITLE: Impact of Boiga irregularis and other predators on native bird populations. (Consolidation of Jobs 1-3).

PERIOD COVERED: October 1, 1982 to September 30, 1983.

SUMMARY

A study of the impact of predation on Guam's avifauna is in progress. Research is concentrating on the brown tree snake, Boiga irregularis, since it is the only predator found on Guam and not in the Northern Marianas.

BACKGROUND

Guam's native birds have declined drastically in recent decades while avian populations in the Northern Marianas have remained relatively healthy. With the exception of an occasional bittern and a small swiftlet population, none of the native land birds occur in the southern two-thirds of Guam, although all once occupied this area.

Introduced predators have been responsible for the extinction of many insular birds. Several species of predators have been introduced to the Mariana Islands including feral dogs, cats, three species of rats, monitor lizards, and brown tree snakes. The brown tree snake was introduced to Guam shortly after WWII and is the only predator occurring on Guam and not in the northern islands.

OBJECTIVE

To determine the impact of predation by Boiga irregularis and other predators on native bird populations.

PROCEDURES

1. Snakes are being collected on a regular basis. Body measurements are taken, sex and reproductive status noted, and stomach and intestinal track examined for remains of prey items.

2. Artificial nest experiments are being conducted to identify predators and compare rates of predation on Guam and between Guam and other islands in the Northern Marianas.

3. Several methods are being employed to determine predator distribution and abundance. A questionnaire was developed to obtain information on snake and rat general abundance, distribution, and range expansion in relation to the avian decline. Additionally, to further determine snake distribution, cliffs are searched for snake sign, particularly shed skins and scats. Experiments are also being conducted with several bird-baited traps, including a Havahart and funnel trap. To obtain relative density estimates, areas known to have snakes are being searched at night with headlights, and cliff potholes are being examined during the day for sleeping snakes.

RESULTS

The stomach contents of 108 brown tree snakes have been examined (Table 1). Of those snakes having prey items, 75.6 percent were birds or bird eggs. Most eggs were from chickens and the high proportion of eggs and birds in examined snakes reflects the fact that many snakes were collected near bird coops.

Artificial nest experiments are in progress. To date, nests stocked with Coturnix quail eggs have been preyed on by rats, monitor lizards, and hermit crabs. For unknown reasons snakes have not been attracted to these nests.

The questionnaire is being distributed throughout Guam and over 200 have been received. The data will be tabulated after at least 300 households have responded (100 each from southern, central, and northern Guam).

Preliminary efforts to trap Boiga and to quantitatively determine densities have been unsuccessful. Two monitor lizards were caught in traps and on another occasion, the prey item was taken but the predator escaped. Snakes or snake sign (cast skins and/or scats) were found over the entire island of Guam. Boiga appears to aggregate at specific sites, possibly for mating.

RECOMMENDATIONS

1. Continue to investigate the life history, feeding ecology, abundance, and distribution of Boiga.

2. Experiment with various baits in artificial nests to ascertain predation rates and with different traps to catch predators.

3. Consider implementing a bounty on snakes to obtain biological data and test the effectiveness as a possible predator control program.

4. Contact universities and research institutes within the range of Boiga for information on natural causes of snake mortality.

Report prepared by: Julie A. Savidge

Table 1. Stomach contents of Boiga irregularis examined from 1967-1983. Results for 1967-1982 are taken from DAWR field notes and records.

Stomach Content	1967	1975	1980	1981	1982	1983	Unk.	TOTAL
Empty			8	10	39	8	2	67
Native bird	1	1	1	1				4
Domestic bird			5	1				6
Exotic bird			3		1	1	1	6
Egg			7	2	3	2	1	15
Shrew					1			1
Rat				1	1	1		3
Kitten				1				1
Rabbit			1					1
Toad					1	1		2
Skink/Gecko			2					2
TOTAL	1	1	27	16	46	13	4	108

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-20
SUB-PROJECT NO.: W-5
STUDY NO.: 8
JOB NO.: 1

JOB TITLE: Captive Breeding of the Guam Rail and other Native Birds.

PERIOD COVERED: October 1, 1982 to September 30, 1983.

SUMMARY

A cooperative program for captive propagation of Guam's endangered endemic forest bird species was begun in cooperation with the American Association of Zoological Parks and Aquariums and several of its member zoos. Construction of outdoor aviaries for the Guam Rail and indoor holding facilities for other birds was begun. One individual each of the Rufous-fronted Fantail and Guam Broadbill were successfully brought into captivity. Initial attempts at developing capture techniques for the Guam Rail have proved unsuccessful.

BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (formerly Division of Fish and Wildlife), census data from roadside counts (GAWR, 1974 - 1982), station counts (GAWR, 1974 - 1982) and transect counts (Engbring, Unpublished Manuscript, GAWR, 1974-82, Jenkins, 1979, 1983) have documented the reduction in range and numbers of the Guam Rail and other native birds.

The Guam rail and other native birds have undergone severe range reduction over the past 20 years and have now virtually disappeared from the southern half of Guam (GAWR, 1981). As recently as 1981, during a joint USFWS and GAWR census of Guam's native birds (Engbring, Unpublished Manuscript), the rail, while rare, was found over almost all regions of northern Guam and was relatively common at Andersen South in highly disturbed habitat. Recent census of Northern Guam by the Guam Aquatic and Wildlife Resources Division in late 1982, show the rail virtually extirpated from Andersen South and major populations now restricted to extreme northern Guam with a few isolated individuals in north central Guam. Similarly the other native birds are now restricted to extreme northern Guam with Pajon Basin (150 ha) the only area still harboring a complete ensemble of all present native birds.

Predation, by a number of introduced predators, is believed to be a major factor contributing to the recent decline in native bird populations. In particular, nest predation by the brown tree snake (Boiga irregularis),

monitor lizard (Varanus indicus), three species of introduced rats (Rattus norvegicus, R. rattus, R. exulans) as well as feral pigs, dogs and cats are believed to seriously affect reproduction of the Guam rail and other native birds. A recent study by the Patuxent Wildlife Research Center, USFWS, has suggested that while pesticides may have played a role in the decline of the native birds in the past, they are not affecting the rail or the native birds at the present time (Grue, Personnel Communication). Avian disease is another possibility being presently investigated in cooperation with the National Wildlife Health Lab, USFWS.

The future existence of the Guam rail and other native birds may well depend on the following:

1. Discovering the factors responsible for the decline and controlling them.

2. Preserving and protecting suitable habitat.

3. Maintaining a captive breeding population in case the wild population goes extinct before the causes can be determined and solutions found. The objective would be the eventual reintroduction of these native species into their original habitat and the re-establishment of viable wild populations.

Specific native bird species to be considered for immediate captive breeding attempts include:

Guam Rail - endemic species
Guam Broadbill - endemic species
Bridled White-eye - endemic subspecies
Rufous-fronted Fantail - endemic subspecies

Eventual candidates for captive breeding include:

Micronesian Kingfisher - endemic species
Marianas Crow - endemic to Guam to Rota

The entire island will benefit both esthetically and culturally by restoration and management of these unique native species.

OBJECTIVES

Implement a captive breeding program for the Guam rail and other native birds by setting up facilities on Guam and in the states with cooperating zoos in the U.S. with the assistance of the American Association of Zoological Park and Aquariums. Develop techniques for release of captive reared birds in the wild once the factors responsible for their decline have been identified and controlled.

PROCEDURES

1. Consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

2. Invite various zoos and aviaries to enter into a cooperative program for the captive propagation of the Guam Rail and other native birds, in order that captive populations be maintained at several locations to protect against catastrophic loss and to maintain genetic variability. Request the assistance of the American Association of Zoological Parks and Aquarium in coordinating the cooperating institutions and in developing a captive population management plan.

3. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.

4. Design and construct appropriate holding and breeding facilities (pens and cages) to allow birds to be held in quarantine for at least 30-days prior to shipment off-island and to allow for maintenance of a captive breeding population on-island as well.

5. Arrange with the National Wildlife Health Laboratory to rapidly process blood smears, serum samples, fecal samples,cloacal swabs,throat swabs, and other specimens from birds held in quarantine, to ensure that cooperating zoos and other institutions are protected from the accidental transmittal of disease.

6. Utilize trapping, mist netting, and other techniques to capture rails and other birds as needed for the captive breeding program. Make an effort to capture mated pairs to increase the probability of success of the program.

7. Develop techniques for the successful release of captive-reared birds into the wild once the factors responsible for their decline have been identified and controlled.

RESULTS

In November, 1982 the decision was made to develop a captive breeding program for Guam's endangered endemic bird species and subspecies. The species considered most endangered were selected for the initial effort included the following:

Chamorro Name	English Name	Scientific Name
Koko	Guam Rail	*Rallus owstoni*
Nossa	Bridled White-eye	*Zosterops c. conspicillata*
Chuguanguang	Guam Broadbill	*Miagra freycineti*
Chichirika	Rufous-fronted Fantail	*Rhipidura rufifron uraniae*

We then reviewed the scientific literature on the breeding biology of the above and similar species. Contact was made by letter with aviculturalists and ornithologists with expertise in captive breeding similar species including the following:

Dr. Donald Bruning, Cruator of Birds, New York Zoological Society, New York City.

Mr. Glen Fraser, Woodhen Project, Lord Howe Island, Australia.

Dr. Eugene Morton, National Zoological Park, Washington, D.C.

Mr. Brian Reid, Wildlife Service, New Zealand.

Dr. S. Dillon Ripley, Secretary, Smithsonian Institution, Washington, D.C.

Dr. Arthur Risser, Curator of Birds, Zoological Society of San Diego, San Diego.

From February 24, 1983 to February 27, 1983, Biologist Robert Beck attended the International Foundation for Conservation of Bird's Symposium Breeding Birds in Captivity at North Hollywood, California. Contact was made with Robert Wagner, Executive Director, and Ed Schmidt, Conservation Committee Chairman of the American Association of Zoological Parks and Aquariums (AAZPA) and Larry Shelton, Curator of Birds, Philadelphia Zoological Society, who agreed to begin setting up a committee to coordinate stateside zoo's participation in this project. Representatives of the following zoos expressed interest in participating:

Dallas Zoo, Dallas Texas
Denver Zoo, Denver, Colorado
Fort Worth Zoological Park, Fort Worth, Texas
Honolulu Zoo, Honolulu, Hawaii
National Zoological Park, Washington, D.C.
Philadelphia Zoological Park, Philadelphia, Pennsylvania
San Diego Zoo, San Diego, California
St. Louis Zoo, St. Louis, Missouri

In addition, during this trip, Mr. Beck visited the facilities of the San Diego Zoo and Wildlife Animal Park and the Honolulu Zoo.

In March the decision was made to captive breed the Guam rail on Guam as well as in stateside zoos. All other species will be bred only at stateside zoos.

In March the AAZPA set up a liaison committee headed by Larry Shelton with Charles Pickett, Curator of Birds, National Zoological Park, Washington D.C. and Kevin Bell, Curator of Birds, Lincoln Park Zoo, Chicago, as additional members. Formal approval for this project was granted by the AAZPA in September.

In late June one individual each of the Guam Broadbill and Rufous-fronted Fantail were captured using mist nets in order to develop capture techniques and to see what problems these birds would present in captivity. Unfortunately, both died within 24 hours probably due to not feeding or drinking (Necropsy report, GAWR, unpublished).

Larry Shelton visited Guam in July for one week in order to assist us in bringing the Broadbill and Fantail into captivity. One individual each of

the Broadbill and Fantail were successfully captured during his stay. Both birds adapted to captivity and a diet of mealworms without difficulty.

Construction of 10'x10' vector and predator proof Guam Rail holding aviaries began in March. These pens are of modular design, and may be changed in size and shape as needs develop. Remodeling of a 15'x30' room in an existing building to be used as a holding facility for other forest birds at our office in Mangilao began in September and was scheduled for completion in late October, 1983.

Unfortunately, no Bridled White-eyes were seen in their last known remaining habitat areas after July 1983. Efforts to captive breed this endemic subspecies were abandoned in September. By October 1983, numbers of broadbills and fantails seen were so low as to cast doubt on the probability of success with these species as well.

Numerous attempts were made to capture Guam Rails for purposes of captive breeding, using both trapping and drive/netting techniques with little success. By the end of September only one Rail had been captured. One egg found during a drive/netting attempt was incubated and hatched with the individual still alive at the end of the Fiscal Year.

At the end of the fiscal year, September 30, 1983, we had in captivity the following birds:

No.	Species
1	Guam Broadbill
1	Rufous-fronted Fantail
4	Guam Rails

RECOMMENDATIONS

1. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

2. Continue to develop a cooperative program with the AAZPA and it's member zoos for captive breeding the Guam Rail and other native forest birds. Captive populations should be maintained at several locations to protect against catastrophe loss and to maintain genetic variation.

3. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.

4. Complete construction of outdoor rail holding and breeding facility and indoor forest bird holding facility.

5. Continue to develop capture techniques for the Guam Rail and other forest birds as needed.

6. Submit Federal Endangered Species Permit application when our birds are listed on the U.S. Endangered Species List.

7. Seek funding for transport of birds to zoos for captive breeding from the Wildlife Preservation Trust, International, U.S. and other conservation organisms.

8. Conduct study of breeding biology in the field on Guam of birds that are to be captive bred.

9. Develop techniques for successful release of captive-reared birds into the wild once the factors responsible for their decline have been identified and controlled.

LITERATURE CITED

Engbring, John. 1982. Distribution and abundance of the forest birds of Guam: Results of a 1981 Survey. U.S. Fish and Wildlife Service.

Guam Aquatic and Wildlife Resources Division, 1974-1982, Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam, Dept. of Agriculture.

Jenkins, J.M. 1979. Natural history of the Guam Rail. Condor 81:404-408.

Jenkins, J.M. 1983. The native forest birds of Guam, Ornithological Monograph #31, American Ornithologists Union.

Report prepared by: Robert Beck

GUAM ENDANGERED SPECIES INVESTIGATIONS
PROJECT E-1-1
Section 6 - Endangered Species Act of 1973

JOB PROGRESS REPORT
RESEARCH PROGRESS SEGMENT

STATE: Territory of Guam

PROJECT NO.: E -1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Investigations into the biology of the monitor lizard and the Philippine rat snake.

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

A study of the impacts of predation on Guam's avifauna and of the biology of predators including Boiga irregularis and Varanus indicus is in progress.

OBJECTIVE

To design and implement a study of the life history, feeding habits, and activity patterns of the monitor lizard (Varanus indicus) and brown tree snake (Boiga irregularis).

PROCEDURES

Because this Job was conducted in conjunction with Job W5-6-1, procedures were the same as reported for that Job.

RESULTS

Because this Job was conducted in conjunction with Job W5-6-1, results are reported under that Job.

RECOMMENDATIONS

1. Continue to investigate the life history, feeding ecology, abundance, and distribution of Boiga. Implement a radio-telemetry study to determine movement and activity patterns.

2. Experiment with various baits in artificial nests to ascertain predation rates and with different traps to catch predators.

3. Consider implementing a bounty on snakes to obtain biological data and test the effectiveness as a possible predator control program.

4. Contact universities and research institutes within the range of Boiga for information on natural causes of snake mortality.

Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1
STUDY NO.: 1
JOB NO.: 6

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1982 to September 30, 1983

SUMMARY

A study of the impact of avian disease on Guam's bird populations is in progress. To date, there is no data implicating any infectious disease.

BACKGROUND AND JUSTIFICATION

Guam's native birds have declined drastically in recent years. With the exception of an occasional bittern and a small swiftlet population, none of the native land birds occur in the southern two-thirds of Guam, although all once occupied this area.

The avian decline on Guam is similar to the decline of Hawaii's native birds. Warner (1968) suggested that extinction of nearly half of the endemic Hawaiian land avifauna and restriction of the remainder to high-mountain forests was due to the pathogenicity of avian malaria, pox, and other possible introduced diseases. On islands, such as Hawaii or Guam, where avian hosts may have lost resistance or never evolved resistance, the introduction of new pathogens or vectors may be devastating.

An in-depth study of avian disease on Guam is being conducted to determine if disease is the cause of the avifauna decline. If disease is found to be a major decimating factor, mitigation steps will then be recommended.

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Interview disease specialists in the Mariana Islands.

2. Sample native and exotic birds using any or all of the following sampling procedures: blood smears, blood collection for hematocrit and serum, swabs (cloacal, tracheal, external lesions) for routine bacterial culture and Salmonella sp. determination and for egg and

cell culture inoculation for viruses, ectoparasite check, and histopathological examination.

3. Supplement study FW-2R-20 (Avian Disease).

RESULTS

Diseases encountered by veterinarians working with domestic and cage birds in the Mariana Islands are listed in Table 1. Most identifications are based on signs rather than clinical diagnoses.

Samples from approximately 150 birds have been analyzed by the U.S. Fish and Wildlife National Wildlife Health Laboratory, and to date there are no data implicating any infectious disease. Samples from another 200 birds (including 63 birds sampled on Saipan) are in the process of being analyzed.

A senior pathologist from the U.S. Fish and Wildlife National Wildlife Health Laboratory spent a week on Guam training DAWR biologist, J. Savidge, in advanced disease investigational techniques.

RECOMMENDATIONS

Future sampling should concentrate on sick birds and potential disease reservoirs as sparrows, quail, pigeons, and chickens.

LITERATURE CITED

Warner, R.E. 1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. Condor 70(2):101-120.

Report prepared by: Julie A. Savidge

Table 1. Domestic and cage bird diseases and infections encountered in the Mariana Islands.

	Guam	Rota	Tinian	Saipan
Viral Diseases				
Newcastle Disease (lentogenic form)	X			X
Pox	X	X	X	X
Leucosis Complex	X			X
Marek's Disease	X			X
Bacterial, Rickettsial and Mycotic Diseases				
Salmonellosis				X
Chlamydiosis	X			
Pullorum	X*			
Coryza	X	X	X	X
Chronic Respiratory Disease				X
Cholera				
Bumblefoot	X	X	X	X
Favus		X	X	X
Parasitic Infections				
Lice	X	X	X	X
Mites	X	X	X	X
Nematodes	X	X	X	X
Trematodes	X			
Coccidiosis	X	X	X	X
Trichomoniasis				X

* Very rare

Law Enforcement

LAW ENFORCEMENT

For FY 83, the Conservation Officers made ten separate arrest in which hunters were charged for using an artificial light as an aid to take game and the possession of wild game out of season. A total of twenty-seven people were involved, two of whom were minors.

To separate arrests were also made for illegal fishing. In one of these arrests two adults were involved while in the other only one adult was arrested.

Additionally, several illegal incidents were investigates which did not materialize into cases because either the Officers failed to make apprehension or warnings were issued as it was thought to be more beneficial at the time. Among these were twenty-three incidents of illegal hunting; thirteen incidents of illegal fishing; two incidents of illegal taking of live coral; and one incident of illegal harboring of wildlife.

The Conservation Officers also assisted Wildlife Biologists in conducting roadside bird counts; nighttime deer counts; and bird (rail) trapping.

In July, the Law Enforcement Office was burglarized. Among the items lost were fruit bat, pig and deer carcasses, firearms, spotlights and hunting knives, all of which were being held as evidence in illegal hunting cases. As a result of the burglary these pending cases are being declined prosecution by the Attorney General's Office.

The employment of two Conservation Officers funded by a sub-grant from the Office of Coastal Zone Management Program was terminated at the end of the fiscal period because no further funds were made available to continue their employment.

The loss of these two Conservation Officers will increase the work load of the remaining staff of six Conservation Officers.